POWER

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The first thing the reader of this Foreword will probably do will be to ask "What is a *Maya?*"

Nine hundred and ninety-nine persons out of every thousand have never heard of a *maya,* so if you are one of them, do not think you are unduly ignorant.

"Maya" is a East Indian word, and it means a great big illusion. In that country they have a saying that "Every man has a *maya,"* which means that everybody is possessed with some idea in which he thoroughly believes, but which, in the end, turns out to be only an illusion.

Mark Twain in his story of the "Jumping Frog" tells of a man who was so confident that his pet frog could jump farther than any other frog on earth, that he wagered all he had on the result of a test. It turned out, however, that his belief was only a *maya,* as another frog easily won the test.

The German Emperor had a large-sized *maya* when he thought that his army could whip the world, his submarines destroy all commerce, and that the other nations would eventually have to bow the knee to him. But he, too, woke up to the fact that he possessed nothing but a *maya.*

Most men have *mayas.*

One of the commonest is the belief that they, themselves, are head and shoulders above their fellows. An exaggerated ego is the greatest of *mayas.* Confidence is an asset. It cannot be overestimated. Because of it many a task has been accomplished that would otherwise not have been done. But to be overconfident, to be saturated with the idea that you are invincible, is to have a *maya,* and if persisted in will, in the end, bring about a sad awakening.

When a man believes, as did the owner of the jumping frog and Kaiser Wilhelm, that he cannot be beaten, then look out for a sudden tumble.

Many men have a *maya* that advancement always goes by favor and merit does not count. They will tell you, in explanation of why they do not succeed in business or in the shop, that it is because they haven't a pull. Instead of giving their best attention to their work, they are always looking for an opportunity to get the desired "pull;" and when promotion does not come their way, they nurse the *maya* until it assumes a gigantic size.

The man who succeeds possesses no *maya* as to the reason for his success. He knows that it has come because of hard work on his part, coupled with the use of the brains which God has given him.

Some people have the *maya* that the world owes them a living, and they are deeply grieved because this imagined debt is not paid. It is well to remember that this old world will never pay any debt, either real or imaginary, unless you get after it hammer and tongs.

There are as many kinds of *mayas* as there are different kinds of people. As a matter of curiosity, take notice for a week of the *mayas* which the people you meet possess. At the end of that time you will be ready to agree with the Indian, that "every man has a *maya*" except, of course, yourself.

Contributed by Frank Dorrance Hopley.

Construction and Operation of a HIGH-PRESSURE UNDERGROUND STEAM MAIN

By L. T. Merwin* and O. LeFever†

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Description of the construction and operation of a 12-in. high-pressure steam distribution line, 5654 ft. long, partly overhead and partly underground, to supply steam for district heating. Details of the solution of problems in expansion, insulation, condensation, etc.

THE Northwestern Electric Co., of Portland, Ore., has recently installed a 12-in. high-pressure steam line to connect its new steam plant with its district heating distribution system. To properly understand the operating and economic reasons that prompted the construction of this line, it is necessary to make a brief statement of the physical layout of the low-pressure system and the steam-electric generating plant—the so-called Pittock Station—of that company.

In June, 1918, there was 78,000,000 cu. ft. of building space connected to the steam-heating lines, with a normal winter demand peak of about 210,000 lb. of steam per hour. This heating load represented approximately the maximum capacity of the central generating station and was actually the ultimate load intended for the system to carry. Since the system was first put into operation in March, 1914, the prospective load for the station has considerably increased owing to building activity in the district covered, and a careful survey made in the early part of last year showed an unconnected but desirable load of some 60,000,000 cu. ft., and this without going beyond the restricted area covered by the present distributing system. At present the company has 57 per cent. of the total load in this district and 55 per cent. of the total revenue.

The Pittock Station supplying the low-pressure steam is a combination steam-electric emergency and central-station steam generating plant. It is in the basement of the Pittock Block—a modern office building covering a block 200x200 ft., lying between Washington and Stark, West Park and Tenth streets. In addition to the functions mentioned, it is the central substation for the distribution of electric energy—both alternating and direct current—for the west side of the city, and is tied to the transmission system of the company by means of two 11,000-volt 5000-kw. three-phase submarine cables under the Willamette River leading to the Albina Substation, the terminus of the 66,000-volt transmission line.

The steam equipment of the Pittock Station consists of six 500-hp. Stirling-type boilers equipped for burning fuel oil, three burners to each boiler. Storage of 1500 bbl. of oil is provided at the station and additional storage of 8500 bbl. in a circular reinforced-concrete tank entirely underground is also provided at Twelfth and Flanders streets and the station tanks are kept filled by pumping from this latter storage through a 10-in. line 2000 ft. long, as well as by gravity feed from tank cars on a spur track at Twelfth and Davis streets.

The boiler header pressure is 185 lb. and carries from 125 deg. to 150 deg. superheat, giving an ultimate temperature of 527 deg. F. The prime movers in the station consist of two 3500-kw. Curtis turbines with 2400-volt three-phase generators connected to the 2400-volt busses of the station. These turbines are one or both floating on the line, the steam end acting as reducing valves for the steam-heating system and the a.c. generators acting as generators and synchronous condensers for voltage control of the Portland district. The turbines are thus at all times in prime condition to carry emergency load and through a simple controlling mechanism automatically maintain a fixed exhaust pressure for the heating system. From this it is seen that the plant is noncondensing and the emergency electric load is carried against the back pressure of the heating system, which was 10 lb. during last winter. The steam

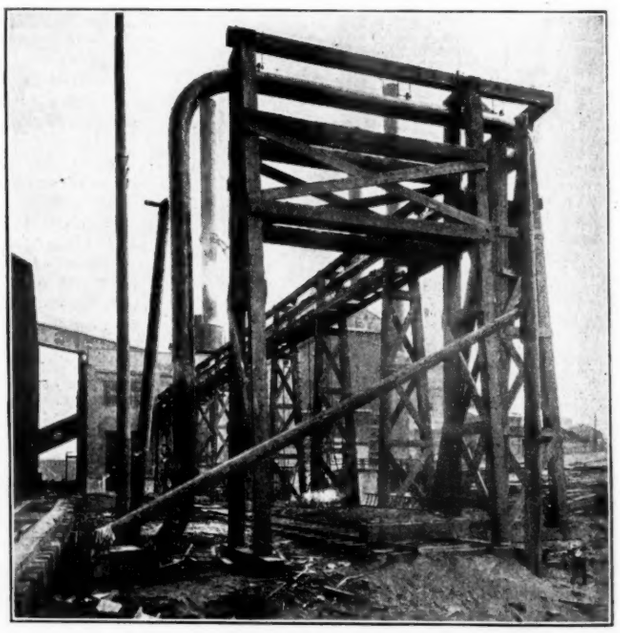

FIG. 1. OVERHEAD SECTION OF STEAM LINE ADJOINING PORTLAND STEAM PLANT

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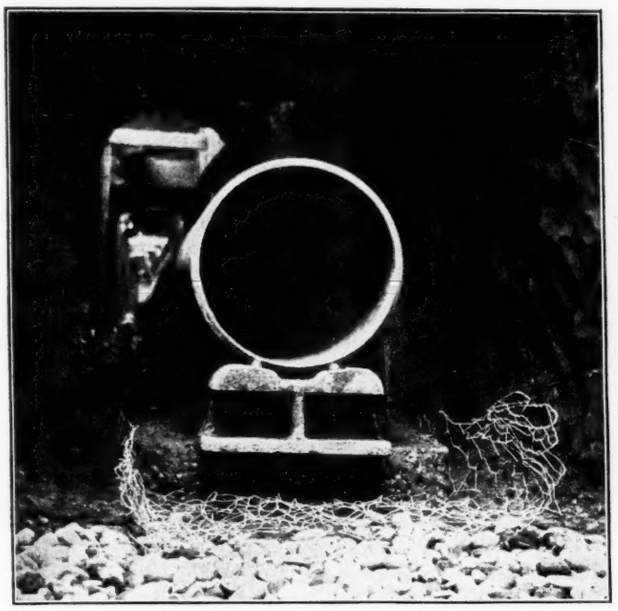


FIG. 2. PIPE SUPPORT AND WIRE MESH FOR TYING CONCRETE BASE TO ENVELOPE

at the turbine exhaust still carries some superheat, and the byproduct electric energy put on the switchboard represents a heat-content loss in the steam of approximately 8 to 10 per cent. The actual kilowatt-hours per barrel of oil under these conditions are about 100. From this it is readily seen that electric deficiency of any great amount cannot profitably be made at this plant, and since a winter duty of 210,000 lb. of steam per hour, on a rated capacity of 3000 b.hp., for steam heating was taxing the station beyond a reasonable duty, some other source than the Pittock Station was needed if the company was to continue to enjoy normal growth.

To meet this demand for steam it was decided to erect a new boiler plant. It is unnecessary to go into the details that finally determined the location of this plant (called the Portland Steam Plant) further than to say that a waterfront location adjacent to one of the largest lumber mills in the district, where mill refuse (hog fuel) was available, was an important consideration. At this new plant "hog fuel" will constitute a considerable portion of the fuel used, and at prevailing market prices it represents an equivalent oil value of from 25c. to 50c. per barrel.

This Portland steam plant was located more than a mile from the district to be supplied by it. It was manifestly impracticable to supply the heating system with low-pressure steam from so great a distance. It was decided, therefore, to install a 12-in. high-pressure main or transmission line from the new plant and connect through a reducing valve to the present low-pressure system. The point of connection was at some distance from the Pittock Station, but with the extension of the 20-in. low-pressure feeder as it is planned, the pressure distribution should be as satisfactory as from that station. This high-pressure steam line connecting through a reducing valve to the low-pressure distributing system is similar to a high-tension electric line connecting through a transformer to a low-tension electric distributing system.

The details of construction of this high-pressure line, some 5700 ft. in length, are of interest. It is designed to carry a pressure of 250 lb. with 200 deg. F. superheat, giving an ultimate temperature of a little more than 600 deg. F. On account of the high temperature and high pressure it was necessary to install extra-heavy steel pipe and fittings throughout. All joints are oxy-acetylene welded excepting at expansion joints, ells, tees, and a few long-sweep bends, where the connections are made with a Van Stone joint. The expansion joints are placed 180 ft. apart and have a travel sufficient to take care of 8½ in. of expansion. The expansion from a dead cold line up to full pressure and superheat is approximately 11 in. per block of 260 ft.

The high-pressure line leaves the new steam plant at an elevation of 34 ft. above ground level, passing over a supporting wooden trestle for approximately 300 ft., where with one horizontal and one vertical bend it drops down to ground level, as shown in Fig. 1. At the power house, or east end of the trestle, an expansion joint is installed, and at the opposite, or west, end a right-angle bend occurs, which is nearly equivalent to a dead end as far as the pull on the line is concerned. Thus, with a 12-in. pipe and 250 lb. pressure we have a west component of approximately 14 tons to be counterbalanced with an east component. At the east end the slip-tube expansion joint has only six 1-in. follower bolts to prevent the line from pulling apart. To anchor the line sufficiently to overcome the equivalent dead-end pressure, heavy bands were welded on the pipe, to which three one-inch stranded plow-steel cables were attached and passed over one of the trestle towers and then down to anchor bolts which pass through a block of concrete weighing about 18 tons. From the end of this trestle the line passes under and up onto the caps of a gradually ascending railway spur trestle, running out from the power-plant yards. The position of the pipe on the railway trestle is between the stringers, just underneath the ties, and above the caps. All the pipe on both trestles is suspended by specially designed hangers.

The railway spur that carries the pipe line reaches an elevation at the west end of approximately 35 ft. above ground level, where it passes over the main-line tracks of the Southern Pacific and the Oregon Electric railways. Just beyond this point the steam line drops down and passes into the underground section for the remainder of the distance to the low-pressure network. This section comprises over four-fifths of the line.

The overhead installation out from the power-plant yards was necessary because a sawdust and decayed wood fill composed the upper surface for a depth of from 30 to 40 ft. The sawdust fill is settling constantly, and to make matters worse, a great many underground springs from the hills above produce a complete saturation of the entire mixture. The footings for the towers of the company's trestle rest on 50-ft. piling.

It would have been preferable to build a special trestle all the way to the underground section, but on account of unsurmountable difficulties in securing right-of-way for a private trestle over the main-line tracks of the Southern Pacific and the Oregon Electric railways, that method was abandoned.

All pipe on the overhead portion of the line is covered with two layers of 1½-in. 85 per cent. magnesia. Around the magnesia is sewed a layer of ducking which is thoroughly painted with a waterproof paint. Over the ducking two separate layers of roofing paper are installed, all joints being broken and sealed with waterproof paint. It is interesting to note that with a temperature of approximately 600 deg. F. on the inside of the pipe the outside of the covering is just perceptibly warm.

The underground portion of the line is laid in a trench 32 in. wide and varying in depth from 4 ft. to 10 ft., depending upon obstructions and the profile of the

ground. On account of the large expansion in the pipe, the line is run without breaks as far as possible, and this throws the grade deeper than would have otherwise occurred had grade been broken more often. Any break in grade is a strain point even when anchored securely, and should be avoided where possible. On account of this line being just a little beyond anything yet at-

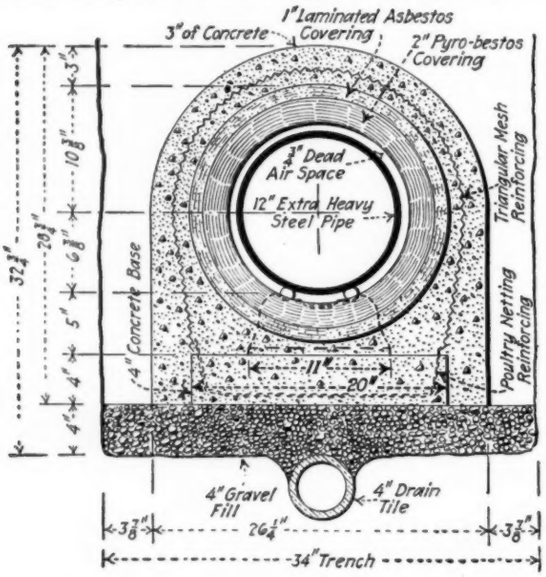


FIG. 3. SECTION OF UNDERGROUND PIPE INSTALLATION

tempted in underground work, precautions were taken to eliminate, as far as possible, everything that might be a source of trouble.

Down the center of the trench and below subgrade is placed a line of 4-in. cement drain tile connected to city sewers wherever possible, usually at the street intersections. Over the top of the drain tile is placed a 4-in. layer of coarse gravel. Next, a 3-in. concrete base is placed to act as a support for the pipe proper.

Supporting pipe guides, as shown in Fig. 2, are placed on the base 9 ft. apart. The top part of the guide contains two semi-circular grooves which act as a path for four 1-in. steel balls which support the entire weight of the pipe. The covering used on the pipe came in sections three feet long, and to facilitate its installation the distance between guides is always on a multiple of three. The guide used weighs 45 lb. and makes a very serviceable and substantial support.

The insulation is shown in section in Fig. 3 and consists of an inner covering of Pyrobestos two inches thick, having a diameter sufficient to allow a three-quarter inch dead-air space about the pipe. The halves of this covering are held in place with bands of No. 22 galvanized annealed wire, all joints being sealed with waterproof asbestos cement. Over the Pyrobestos covering is placed one inch of laminated asbestos, breaking joints with the first layer of covering and having all joints sealed as above. Around the three inches of covering an outside casing of building paper is installed, lapped and tarred on longitudinal and vertical joints to make a water-tight job.

A three-inch envelope of concrete mixed 1-3-5 is then poured around the total circumference of the covering. Tar paper is placed over the concrete and the line is complete, ready for backfill.

The high-pressure line ends on Fifth St., 90 ft. south of the 12-in. east and west main on Yamhill St. A reducing valve preceded by a steam separator and provided with a bypass connection is installed at this point, where the pressure is reduced to 10 lb. The 90 ft. of line between the reducing valve and the Yamhill St. main is 20-in. pipe, provided to slow down the velocity of the steam before it reaches the low-pressure network. The reducing valve was in operation only three or four days when the diaphragm in the pilot valve "went bad." A new diaphragm was made up, consisting of one layer of $\frac{1}{16}$-in. cloth-inserted rubber packing and one layer of $\frac{1}{16}$-in. wire-inserted asbestos, which has given no trouble up to the present time. The cloth-inserted sheet was made up special at the Portland Rubber Mills, using the best grade of live rubber and heavier cloth than used in the ordinary C. 1 sheet. After about 10 days of operation the large main diaphragm of the reducing valve "went bad." A new diaphragm was constructed, consisting of three layers of $\frac{1}{16}$-in. C. 1 sheet (same as above) and two layers of $\frac{1}{16}$-in. wire-inserted asbestos, the rubber and asbestos sheets being alternated. Since the last repair the valve has given perfect regulation. There have been times when the pressure on the high side of the reducing valve would swing from 50 lb. to 70 lb. in five minutes without varying the pressure on the low side of the valve a quarter of a pound. A view of the reducing station before the erection of the bypass valve and nipple is shown at Fig. 4.

A reducing valve is installed at the power-plant end of the high-pressure line, which will ultimately maintain a constant initial pressure, but owing to a mistake of the manufacturers when the valve was shipped the wrong parts for the proper reduction were supplied so at present the high line is floating on the boilers. As soon as this valve is put in operation, the initial pressure will be reduced to about 150 lb. for the light summer load, which will ease up on the line considerably.

There is one feature of the line that has hardly been touched so far, and that is the matter of oxyacetylene

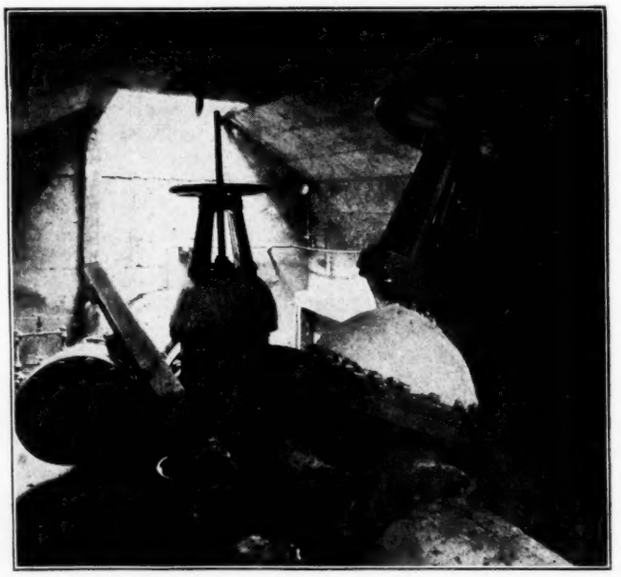


FIG. 4. UNDERGROUND PRESSURE-REDUCING STATION

welding. This part of the work gave trouble up to the very finish. In all the welding work with standard pipe there was little trouble, but when the welders tackled the extra-heavy pipe they learned that they were up against a different proposition for the surplus heat necessary to weld the extra-heavy pipe made it exceedingly difficult to keep the pipe in line. The method finally adopted was to place the two ends of the pipe to be welded $\frac{3}{16}$ in. apart, and to tack the pipe in five places; even

hen, if the welder did not watch himself very closely e was likely to turn out a crooked joint. A hydraulic est of 1000 lb. per sq. in. was put on the line, 180 ft., he distance between two expansion joints, being tested at a time. This test was rather severe, but only one weld on the entire line ever failed under test, although many leaks showed up which required a certain amount of reburning to be done.

The Van Stone flanges previously mentioned came with three feet of pipe attached, having one end beveled for welding. Between all flanges corrugated steel gaskets coated with a commercial pipe cement were used. On starting the line up the first time not a single leak occurred around a flange. However, since the line has been in operation there has been occasion to shut down a couple of times, and each time, on starting up, a leak occurred around a flange. It was found that with the high temperature the pipe cement over the gasket becomes so hard that it is impossible to pull up on the flange bolts and stop the leak, it being necessary to take out the gasket and clean the surfaces before a tight joint can be made. So the gasket is now "doped" with the old reliable red lead, lampblack and oil.

Special care was exercised in the design and construction of the line to avoid traps, as a high-pressure trap on an underground system is generally a source of trouble. Only four traps are installed, two on the overhead portion and two on the underground. A fifth bleeder occurs at the reducing station, but the water at this point is allowed to blow through direct to the low-pressure side through a ½-in. pipe which can be throttled with a globe valve. Under heavy load conditions the superheat in the line more than takes care of the insulation losses, so theoretically there would be no water of condensation, but on account of the exceedingly low conductivity of superheated steam, the film condensation taking place on the pipe walls does not entirely flash back into steam. The traps used are of the bucket type with bottom inlet and top outlet and are very easily installed.

At the reducing station are four direct-reading, long-distance transmitting, pressure gages, two on the high side of the reducing valve and two on the low side. These instruments transmit the high and low pressures, electrically, to recording pressure gages located on the operating floor of both the new steam plant and Pittock Station. Long-distance temperature recorders working on the same principle as the long-distance pressure recorders are to be installed very shortly. Thus it is apparent that the operators at Pittock Station and the new steam plant will at all times know the exact temperature and pressure of the steam at the reducing station and will be able to report immediately any trouble developing in the reducing valve.

One hundred feet beyond the reducing station is installed a back-pressure valve connected to a 12-in. standpipe, 30 ft., high, located just nsiide the curb line. A street-railway trolley pole was replaced with the standpipe, which was painted to match the other poles. It fulfills the dual function perfectly. The back-pressure valve is for emergency use only to relieve the pressure in case the reducing valve fails to operate.

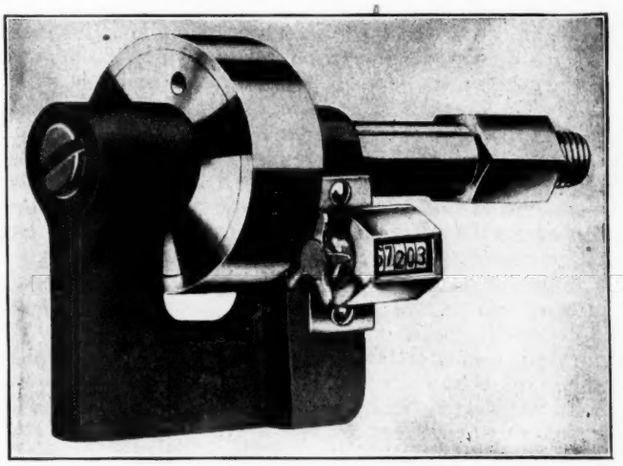
The line has been in operation now for several months and has handled the entire down-town steam load at all times when the electric demand did not require the Pittock Station to pull electric load. As stated in the fore part of this paper, the turbines at Pittock Station run noncondensing and exhaust directly into the low-pressure network. Up to this time there has been no serious operating trouble and the engineers feel quite confident that the line will pull as successfully under full-load conditions as at present. A steam-flow meter will be installed at the delivery end some time in the near future, but until such an instrument is placed there is no accurate method for determining the amount of steam delivered through the new line, but on an estimated load of 140,000 lb. of steam per hour, the drop was only thirty pounds, much less than figured in the preliminary estimates.

No tests have yet been made to determine the efficiency of the covering, but theoretically the line losses will absorb all the superheat until the load passes 40,000 lb. of steam per hour. On several cold mornings temperatures on the low side of the reducing valve reached 360 deg. F. In the company's old type of construction the steam main passes through an asbestos-lined wood pipe casing, and the high temperature of the steam set the log on fire on two different occasions. To eliminate this hazard and reduce the superheat, there has been installed in the steam line three sets of atomizing water jets. These jets will be operated automatically in practically the same manner as the automatic temperature control on a hot-water boiler, but at present are manually operated whenever the steam reaches a dangerous temperature.

Dwight Motion Recorder

A simple and ingenious device designed to record the travel of an elevator, a mine hoist, or, in fact, the movement of any machine having a rotary motion, is made by the Dwight Manufacturing Co., 12 South Jefferson Street, Chicago, Ill. In the case of an elevator the recorder shaft is screwed into the end of the drum shaft, or if it is not desired to tap the center of the shaft, a flange connection is provided, with a ball fitting into the usual center to insure proper alignment of the recorder.

As shown in the illustration, the device consists of an annular ring mounted free on the shaft, two end disks and a counter operated by a pin at the periphery of the



EXTERIOR OF MOTION RECORDER

ring. The inner disk is attached to the shaft, and rotates with it, imparting its motion to the annular ring by means of a ball clutch between the disk and the inner surface of the ring. If the movement of the drum were always in the same direction, no additional mechanism would be necessary, but in the case of an elevator the up and the down movements balance, so that if the revolutions of the drum in the reverse direction were counted, the readings would coun-

terbalance and the gage would stand at zero. To obviate this difficulty, the outer disk is secured to the frame and is stationary, but a ball clutch prevents the ring from rotating in the reverse direction. Thus the drum revolutions in one direction only are recorded. Doubling the reading and multiplying by the mean circumference of the drum gives the cable movement and consequently the travel of the car. Where a meter on the cage might register partial trips as full car travel, the present device accurately records the movement.

Knowing the mileage on the car or the cable is useful information. It gives directly the life of the cable, and in reducing power consumption or operating cost to a unit basis, the car mileage is essential. With an electric elevator, power and mileage readings could be taken simultaneously and a comparison of records would show whether the car is operating at or below standard and indicate whether it requires attention. The same reasoning might apply to any other rotating machine or shaft of which it is desired to keep a record.

The device illustrated is intended for use where the revolutions in opposing directions balance. A modification of the meter, however, has been perfected for shafts having a predominant direction. Both forward and backward movement is counted and the total number of revolutions recorded.

Some Considerations of Oil Fuel for Boilers

AT THIS time, when so much attention is given to the use of fuel oil on account of the scarcity and increasing price of coal, the conclusions of the United States Naval Liquid Fuel Board, although made in its report a number of years ago, are as true for conditions today as they were for the conditions at that time, and should therefore be of interest to power-plant men. The report goes on to say that, as a result of the extended series of tests, the following conclusions have been drawn: Our comment appears in brackets.

First, that no difficulty should be experienced by an intelligent fireroom force in burning oil in a uniform manner. It need likewise require but little experience upon the part of the skilled water tenders [or firemen] to be able to detect, either from the character of the roar or hissing noise, or by the color of the flame at different points, an approximate idea both as to the evaporative output and efficiency conditions.

For general purposes on shore, high-pressure steam is a more satisfactory spraying medium than air. The use of steam, however, as an atomizing agent for naval purposes will undoubtedly require a considerable increase in the size of the evaporating plant, and this must be considered of importance. The necessary increase of the evaporating plant is practically the main objection to the employment of steam as an atomizing medium for liquid fuel aboard naval and merchant vessels.

While the use of steam as a spraying medium will undoubtedly prove most satisfactory for general purposes, the results of the tests show that the consumption of fuel oil cannot be forced to as great an extent with steam as the atomizing agent as when highly heated compressed air is used for this purpose. The advantages of air as the best spraying medium for severe forced-draft conditions are due to the fact that this atomizing agent, after entering the furnace, is a supporter of combustion. With the use of steam as an atomizing agent the rarefied vapor simply displaces a certain portion of that air that is requisite for complete combustion. If it were not for the fact that air compressors necessary for supplying an atomizing agent are bulky and heavy and require considerable room for their installation, the question might be considered whether for warship purposes it would not be advantageous to effect an installation whereby either air or steam could be used at will.

In every fuel-oil installation special provisions should be made for the removal of the water that will collect from various sources at the bottom of the supply tanks. Even a small amount of water pumped to the burners will interfere with the efficient and satisfactory work of an oil-fuel installation; as it is essential with every boiler plant to secure a uniform, if not large output, the annoyance and evil of occasionally pumping water rather than oil to the burners cannot be overestimated.

The evaporating efficiency of crude and refined oil is practically the same no matter from what locality the oil may come. The danger of using crude oil, however, is much greater. As it should not be an expensive matter to build refineries near one of the terminal points in a pipe line, the expense of such refining should not increase to a perceptible degree the cost of such oil, since the sale of the byproducts of crude oil would often pay in great part the expense of distillation.

The great benefit of heating air necessary for effecting combustion cannot be doubted.

To provide a uniform supply of oil to the burners the oil should be heated by some simple means. It can be expected that the burners will be operated much more satisfactorily when oil is thus heated, it being understood that the heating has been carried only to the point well below the temperature of the deposition of the hydrocarbon.

Where the use of liquid-fuel installation is projected, there should be a reserve of burners installed, and these burners should be of a design that would permit rapid examination, thorough overhauling and easy renewal of special parts by the fireroom forces. Careful experiments, as well as extended experience, have shown that by increasing the number of burners there is not only a more uniform but a more efficient distribution of flame. There is also a minimizing of the blowpipe effect as well as a marked reduction in the amount of noise in the furnace.

The hygrometric state of the atmosphere has a noticeable influence on the boiler efficiency and capacity.

To secure in oil-fuel installations more uniformity of conditions in the furnace and to decrease the noise where air is used as a spraying medium, an air-cushion tank for the oil-supply pump should be installed. Such a tank would break the pulsations of the pump and serve a similar purpose as the regulating air chamber of an ordinary steam pump.

The board lays emphasis upon the necessity for strainers that are not only adequate to pass the required amount of oil but capable of being easily cleaned.

Extended experience in the burning of crude oil will confirm the opinion that the simpler the furnace the greater its efficiency. The erection of brick arches only tends in many cases to reduce the volume of space necessary for effecting complete combustion. In Scotch boilers there should be a simple vertical brick lining of the back combustion-chamber wall and a lining of the front end of the furnace for about a third of its length. No design of fuel-oil installation should be permit-

ted for marine purposes which would not permit the renewal within twenty-four hours of all grate bars, so that a return to coal could be accomplished within a reasonable time in case of failure of oil supply. In this connection it is interesting to note that in November, 1919, the United States Shipping Board Emergency Fleet Corporation has secured sufficient oil-storage stations along the ocean highways to refuel our merchant or naval ships in any part of the world.

For Scotch boilers the board recommends the use of retarders in the tubes, so as to effect a more even distribution of the gases and the more thorough contact of the total volume of gases passed with the tube surface.

As regards boiler-room labor the board is of the opinion that cheap labor cannot be employed for this work, as there will be resulting damage, annoyance and danger if the operation is assigned to unskilled labor.

The efficiency of oil plants will be primarily dependent on the character of the installation of fittings and auxiliaries. The form of boiler, so long as it is manufactured in accordance with general well-known principles, and all its parts are accessible for overhauling, will play a small part in extending the use of crude petroleum. The method and character of the installation, however, are all-important, and therefore the work of designing and constructing such a plant should be entrusted only to those who have given careful study to the matter and who have had extended experience.

Where crude petroleum has undergone a light refining or distillation, no ill effects result to modern steel burners. (Crude petroleum is not used for fuel purposes today to any material extent. The crude petroleum is topped, the gasolines being driven off.) From the standpoint of endurance of the boiler the advantage, if any, is with oil. Crude oil, however, by reason of its sulphur, and corrosive effect, has a greater tendency than refined oil to attack the tubes of modern boilers.

The value and necessity of installing a series of draft gages between the ashpit at the base of the stack are conclusively shown. As a result of the study of the draft conditions at different points, there were changes made in baffling the gases which were of decided benefit. It is therefore recommended that for experimental purposes a series of draft gages be put into the boilers for observation of the draft conditions at various points.

Practically every form of commercial firebrick that was used in the boiler for the purpose of forming a deflecting arch disintegrated either under the action of the intense heat generated or due to the action of the acids in the oil or coal. In case any form of arch or bridgewall is essential to the efficient or forced burning of liquid fuel, then special experiments should be conducted to secure a refractory brick that would possess endurance under the severest of forced-draft conditions.

[Since this was written some progress has been made in the development of refractory material to stand the high furnace temperature that fuel oil produces. But just as in burning coal on stokers at high rates of combustion, all blowtorch action or its equivalents must be minimized, so too must these be minimized with oil. One should not expect a firebrick to live up under the intense heat produced, for example, by one large burner placed immediately under the tubes or under the crown-sheet sheath of a horizontal return-tubular boiler set low where the heat generated at a short distance from the burner must be equivalent to, and often is greater than, the heat liberated by the expanse of fuel bed that formerly covered the entire grate area.]

For naval installations there should be supplied a fuel oil that will not flash under 175 deg. F. The higher flash point required for naval than for merchant vessels is essential for the following reasons: (a) The war vessel must be kept in readiness to proceed to the tropics on immediate notice, and the firing of guns subjects the naval ship to danger conditions to which other types of vessels are not exposed. (b) The fitting of numerous transverse bulkheads and a protective deck in a naval installation, combined with the fact that both machinery and boilers are exceedingly crowded, make it extremely difficult to properly ventilate certain compartments, and therefore in warships it will be necessary to use special precautions, both in the stowing and in the handling of oil fuel. (c) The fact that a large number of men must be permanently housed beneath decks of the naval ship will make it difficult to prevent the use of open lights in some of the lower compartments, and thus the danger of using oil as a fuel from this cause will always be greatest in naval vessels.

The board lays particular stress on the necessity for a continued supply of oil. Special efforts at the testing plant were required at all tmes to maintain a reserve supply of coal. [For stationary boilers, too, experience has shown, the oil-burning plant should have tank capacity for at least two weeks' supply. In this connection it is interesting to observe that at the plant of the Tamarac Mills, of Pawtucket, R. I., a large oil-burning power station was constructed, with no provisions whatever for the storing or the handling of coal or the storage or handling of ashes.]

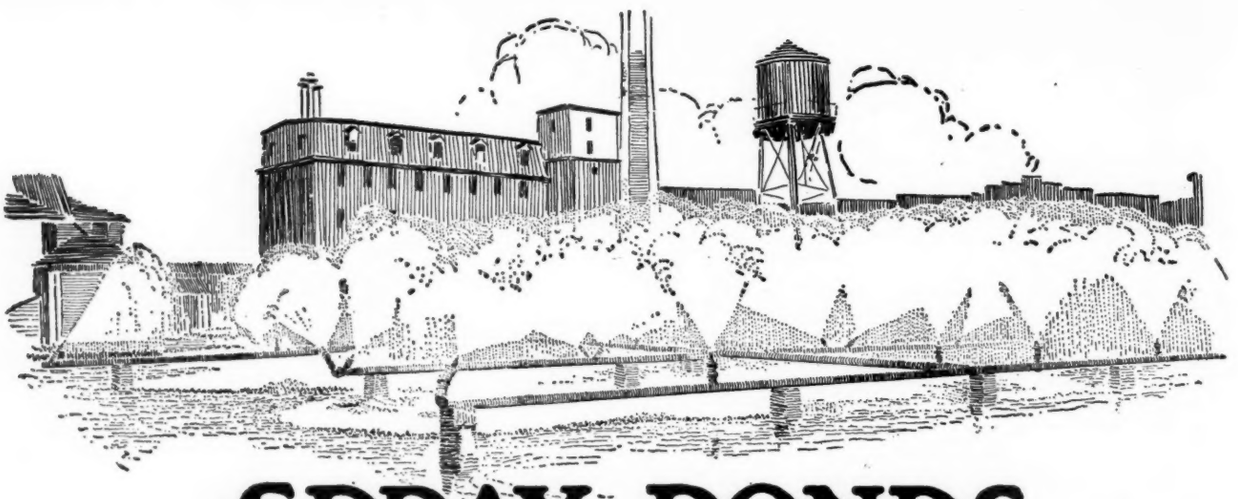
Economical Advantages of Oil Fuel

The relative evaporative efficiency of oil and coal as a fuel, as determined by this extended series of experiments, is practically in the proportion of 15 to 10. The actual superiority of oil will be considerably greater, for in the coal experiments unusual skill was exercised in the management of the fires. Lump coal of superior quality was used, and as the tests for coal were of comparatively short duration the resulting loss from cleaning fires was much less than would occur in actual service. The oil experiments, however, were carried on under conditions that more closely approximated those that could be secured on board the sea-going vessels. The actual evaporative efficiency of a pound of oil as compared with a pound of coal will, therefore, be at the ratio of 17 to 10, and these figures can be regarded as substantially correct. It will be found, practically, that the thermal efficiency of a pound of oil is the same whether the oil be crude or refined.

The relative efficiency of oil and good steaming coal from the naval standpoint of fuel supply and warships may be regarded as in the ratio of 18 to 10.

The board is, therefore, of the opinion, after special investigation of the comparative merits of coal and oil, that in regard to the evaporative efficiency a long ton of the best quality of coal such, as Cardiff or Pocahontas coal, is equivalent to 4½ bbl. of oil; and that, in a long ton of an inferior quality of coal the evaporative effect will be that obtained from only 3 to 3½ bbl. of oil. This comparison is based upon the assumption that, until greater volume is permissible for the installation of naval boilers, it will not be possible to secure in practice an evaporation from and at 212 deg. F. of over 14 lb. of water per pound of fuel oil. Increased efficiency, however, may be secured by heating the air requisite for combustion.

[It will be seen from the foregoing statements that, in land installations, where it is possible to provide adequate combustion volume, far more than is usually permissible on board ship, the over-all efficiency of the oil-burning boiler should be considerably higher, and in fact is higher, than is possible aboardship.]



SPRAY PONDS

By H. M. Brayton

A study of some of the more important points to be observed in their design and a comparison with the cooling tower.

IN CONDENSING plants where a plentiful supply of circulating water is not available, some means must be provided for cooling this water so that it can be used over and over. Two devices are in use—the cooling tower and the cooling pond or spray pond.

The action of the cooling tower depends mainly on the giving up of heat by the hot water to the air. The tower is usually a high structure, circular in section, with its interior filled with some sort of bafflework designed to break up the water into fine sheets or sprays. The hot water is delivered to the top of the tower while a strong current of air is injected into the tower at the base by means of a forced-draft fan. The air and water come into intimate contact within the tower, and the water is cooled and the air heated. The cooled water from the tower is collected in a basin at the foot, and the condenser water is taken from this supply.

The action of the spray pond depends on the cooling of water by evaporating part of it and thus taking from what was left the heat of vaporization necessary to do the evaporating. Conduction and convection were not relied upon for cooling. This effect is present, also, to a small extent in any cooling tower as some of the water evaporates and carries away heat in the form of steam.

Cooling in the modern spray pond is accomplished, as nearly everyone knows, by spraying the hot water through nozzles designed to break the water up into very fine particles or spray, thus aiding the evaporation tendency. A great deal of experimental work has been done by American engineers in the perfection of these nozzles. At the present time there are several different designs on the market, all of which apparently give good results.

Sprays are arranged in rows and placed a certain distance apart, depending upon the system employed. Theoretically, the farther we place the sprays apart the better the cooling. In practice we are, of course, limited in this respect to the land available and the cost of the pond. These spray heads are attached to the main pipe line either in clusters of five or six, or alone. The rows of sprays are generally placed closer together than the nozzles in a single row. This arrangement is supposed to create a draft between the rows and thus produce better cooling. The general direction of the current of air is upward, however, and this consideration would seem to be somewhat theoretical.

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Efficiency of Spray Ponds

About the only way to express the cooling of water in terms of a per cent. efficiency is to compare the amount of cooling that has resulted under a given set of conditions with that which would have resulted had perfect cooling conditions prevailed. By perfect conditions we mean the cooling of the water down to the wet-bulb temperature, which is, of course, the lowest possible to obtain. We may express this in terms of an equation as follows:

$$E = \frac{T_1 - T_2}{T_1 - Tb} \times 100$$

where

E = Per cent. efficiency;
T_1 = Initial temperature of the hot water;
T_2 = Final temperature of the water after cooling;
Tb = Temperature of the wet bulb.

So many factors affect this value that the reader had better consult the paper by Prof. C. C. Thomas on this subject, read before the American Society of Mechanical Engineers at the December, 1917, meeting. The value of Tb may be taken from any humidity table for the conditions under consideration. For rough calculations the reader may use a value of $E = 70$ per cent. and not be far off.

Many people do not realize that the maximum cooling obtainable in a spray pond is dependent on the relative humidity. This factor is more important than the air temperature because it is possible to cool water below the air temperature on days of low humidity. The Spray Engineering Co. quotes tests that show a cooling of 14 deg. F. below the air temperature. The relative humidity stood at 19 during these tests, which is, of course, unusually low. It is more common practice to be able to cool the water to within a few degrees of the wet-bulb temperature. If the engineer will consult

the weather reports for the locality in which the pond is to be located and get from them an average value of the humidity for the last few years, he will be able to draw an intelligent conclusion upon the amount of cooling he can obtain.

If the difference between the temperature of the water to be sprayed and the wet-bulb temperature at the given humidity is more than about 20 deg. F., it will generally be necessary to spray the water twice in order to get it down to the desired point. This is undoubtedly due in large measure to the impracticability of placing the spray heads very high above the surface of the pond. There is also a limit to the fineness of the spray which it is possible to obtain, and it is now generally agreed that fineness of spray is more important than a long passage of the water through the air.

When Double Spraying Is Necessary

When it becomes necessary to spray the hot water twice in order to obtain the desired low temperature, two possible cases arise. One of the most common methods is to build two ponds adjoining, with a single wall or bank between them. The water is taken from the hotwell by the pumps and delivered to the sprays in one of the ponds. It is then collected in a sump, usually in one corner of this first pond, and piped back to the pumphouse, where another pump delivers it to the sprays of the second pond, where the final cooling is accomplished. Here again the cooled water is collected in a sump and piped to the condenser pumps, which completes the cycle. Such a system must be arranged so that either pump can deliver to either pond and so that either pond can deliver to the condenser pumps. Either pump must be so arranged that it can draw water from the hotwell. It will usually be advisable to arrange one spare pump in such an installation, so piped and valved that it can take the load of either of the two others when they break down or are in need of overhauling. In winter it will usually be unnecessary to use more than one pond. The climatic conditions locally will greatly affect the details of the design. In such a system we have one pond handling real hot water and the other relatively cool water. The former is quite apt to steam badly, especially on cold days, and if the prevailing winds are in the right direction this spray and moisture-laden air will drift over the other pond, seriously affecting the latter's efficiency. In fact, this trouble may be so pronounced that very little cooling will result in the second pond. It will become apparent at once that in such a design the direction of the prevailing winds is an important consideration. Again, this heavy moisture or fog may injure adjoining property which may or may not belong to the same company.

Mixing Hot and Cooled Water Before Spraying

Another method, when double spraying is necessary, is to mix the hot water from the condensers with some of the cooled water from the pond before it is sprayed at all. This lowers the temperature of the water in proportion to the amount of cooled water added. This mixed water is then carried to the pumps and forced by them to the sprays and requires but one spraying to reach the same low temperature obtained by the use of two ponds. Let us further analyze this arrangement and note its advantages. In the first place, but one pond is required, which saves the dividing wall. But one pipe line need be laid from the pumphouse to the pond. If this distance is long, the saving will be considerable. We have succeeded in eliminating the heavy moisture which was due to the spraying of the hot water. In cold weather part of the sprays may be shut off if properly valved. The reader must not draw the conclusion that a smaller pond is possible with this arrangement. Generally speaking, this would not be true, because the water that is taken from the pond to cool the hot water in the mixing well is really sprayed twice, and so the pumps and nozzles have the same work to do as if the double spraying were done in two separate ponds. If the hot and cooled water were mixed in equal proportions, this statement would be exactly true.

It may be found, however, that it is unnecessary to add equal parts of the cooled water in order to reach the desired temperature. Valves should be so arranged that the operator can adjust this mixture to meet the daily conditions, and he should at no time add more of the cooled water than is necessary to get results from the pond. A thermometer showing the temperature of the condenser feed water, together with a chart showing the temperature possible under the various conditions of temperature and humidity, is all that is needed. Perfect control is then always possible, and even temperature of condenser water means even and maximum efficiency the year around. It may happen that more than an equal quantity of cooled water will have to be added to get results. This would appear on hot, humid days in summer. If the spray system is flexible and has been designed for a little excess capacity, this will be possible and your plant will be able to maintain its vacuum as well as on any other day. This condition would really mean that part of the water was sprayed a third time.

It is of interest and may be of some value to the reader to express in the form of an equation the relation existing between the temperature of the hot, cooled and mixed waters and the quantities involved in each case. We will use the following notation and assume that the specific heat of water is constant throughout the range of temperatures employed. This assumption is almost exactly true. Let

Q = Quantity of hot water from condensers in gal. per min.;
Q' = Quantity of cooled water from pond in gal. per min.;
Q'' = Quantity of mixed water going to spray pumps in gal. per min.;
T = Temperature of hot water in deg. F.;
T' = Temperature of cooled water from pond in deg. F.;
T'' = Temperature of mixed water passing to spray pumps in deg. F.

The following relations must hold:

$$Q'' = Q + Q' \qquad (1)$$

and $8.36\ Q''\ T'' = 8.36\ Q'\ T' + 8.36\ Q\ T$. or $Q''\ T'' = Q'\ T' + Q\ T$. Therefore

$$T'' = \frac{Q'\ T' + Q\ T}{Q''} = \frac{Q'\ T' + Q\ T}{Q' + Q} \qquad (2)$$

The quantity 8.36 used in these equations is the number of B.t.u. required to raise one gallon of water one degree. Note, however, that this value 8.36 cancels out in all members of the equation. Also note that the quantity has been considered in gallons per minute, but that the equations are entirely independent of the unit of quantity, as well as of the unit of time, as long as the same unit is used throughout. In other words, the quantity may be in cubic feet or pounds, and per minute, per second per hour. It makes no difference in the final result, which is the obtaining of the temperature of the mixed water.

It may well happen that the designer or operator desires to know the value of Q'; that is, the quantity of cooled water from the pond which will be necessary to

obtain a certain temperature of the mixed water. Equation (2) may be rewritten for this purpose in the following manner:

$$Q' = \frac{Q\,(T - T'')}{(T'' - T')} \qquad (3)$$

Such an equation would prove of value when the line from the pond to the hotwell was equipped with a meter. It would aid the operator in quickly arriving at the desired amount of cooled water necessary to obtain results.

Depth of Pond as Affecting Efficiency

There is another factor which affects the efficiency of a spray pond, and that is the depth of the water employed. Of course, the more shallow the pond the greater will be the area exposed to radiation and conduction in proportion to the body of water. This would seem to be an asset. Experience has shown, however, that a deep pond is the more desirable, when possible, because of the lag in temperature between day and night made possible by the smaller surface exposed to the heat of the sun and the larger body of water. The pond will cool down considerably during the night and will not rise to as high a value during the day in the deep pond. This lag will keep the average temperature of the pond during the twenty-four hours several degrees below the average for the shallow pond. This is a decided gain. On the other hand, the deep pond costs more to build and the designer must strike a balance between the interest on his investment and the gain to be realized by the lower temperature of the water. This may not always be an easy thing to do. Practice has shown that a pond should be between six and eight feet in depth to give good results.

Spray ponds may be made completely of concrete, although a cheaper method is to use as little concrete as possible and make the walls and bottom of puddled clay. The pond should be made to extend mostly below the surface, rising not more than one or two feet above. The exact location is usually determined by the head desired on the pumps. The sump, or collecting basin where the water is taken back, should be made of concrete and screened to prevent foreign matter from passing to the pumps and condensers. The concrete around the sump must be well bonded into the clay to prevent leakage around or under it. A spray pond placed well above the ground is a menace to surrounding property, because in case of failure a flood with its accompanying damages results. Provision should be made whereby the pond may be completely drained and cleaned. An overflow must also be provided sufficient in size to take care of the maximum amount of water which could ever reach the pond. In arriving at the size of the overflow, it must be remembered that the water is coming to the pond under some head and flowing from it through the overflow under practically no head, and that under these conditions a larger-sized pipe must be used for the overflow than is used to bring the hot water in.

Pumping Systems for Spray-Pond Service

Let us look now for a moment into the pumping-system side of the spray pond. The centrifugal pump is now almost universally used in this service. The reasons for this are its cheapness, good efficiency, flexibility and sureness of operation. It is simple in construction and therefore causes little trouble. Foreign matter will, to some extent at least, pass through it without injury to the pump, and there are no valves to get out of order.

There are some fundamental points to be observed in a centrifugal-pump installation. But one pump should ever be run on one suction. If two or more are made to use the same intake pipe, trouble will be experienced if it is desired to start one with the other running. The one that is running will tend to lose its suction. The same rule applies, although to a lesser degree, with the discharge pipe. Check valves may be employed to overcome this, but when at all possible each pump should have a separate discharge line. If the pump is placed above the level of the supply pond, provision must be made for priming the pump with a separate pipe from some other source. Frequently, the city water supply may be utilized for this purpose. When such conditions exist a foot valve must be placed in the suction line near the pump, otherwise the priming water would all run back to the well. It is usually good practice to place a gate valve in the suction line when the water comes to the pump under head. The pump is then accessible for repairs.

The Pump Should Not Be Placed Too High

When the pump is placed above the level of water in the well, care must be taken to see that it is not placed too high to give the best results. It is not possible to raise hot water by suction as far as it is cold water, owing to the evaporation of the water in the partial vacuum, which prevents the air pressure on the surface of the water in the pond from forcing water up to the pump. Most of the pump manufacturers furnish data from actual tests showing the amount of suction head possible for various temperatures of the water. This suction lift will also vary some with the altitude of the locality, and if very far above sea level this factor should be considered. At water temperatures above 160 deg. F. the pump must be fed under head. This is higher than usually met with in power-plant work.

It may be laid down as a good working principle to place the pumps low enough so that they may at least be filled by gravity when not running. This makes priming automatic, and with the gate valve closed on the discharge and the suction valve open, the pump is always primed and ready to start. Check valves should always be placed in the discharge line whenever the head worked against is large or when more than one pump discharges into one main. The check valve must be placed next to the pump and the gate valve beyond for two reasons: First, to prevent water-hammer from injuring the pump; and, second, to make the repair of the check possible without stopping the whole system. The suction pipe which extends into the water in the well must be well inserted to prevent a whirlpool action from drawing air into the suction line. If very much air enters in this way, the pump will lose its water and will have to be stopped and reprimed. This applies, of course, only in the case of pumps that are placed above the water level.

In concluding, the relative merits of spray ponds over the cooling towers might be enumerated:

1. They produce better and more uniform cooling.
2. They are cheaper in first cost and much cheaper to maintain.
3. Much lower head is required on the pumps, which represents a saving in power.
4. There is no air to handle or fans to get out of order.
5. Better control and more flexible is afforded.
6. They give a better supply of water for fire purposes.

The tower has one advantage of being available for use in close quarters.

Polyphase Watt-Hour Meters Connected on a Single-Phase Circuit

By E. A. FISCHER

FOR the registration of the energy consumed in two- or three-phase circuits, single-phase meters may be used or specially constructed meters may be employed. In Fig. 1 the two phases of the two-phase circuit are separate and therefore become two single-phase circuits; each watt-hour meter will register the power transmitted on its respective phase and the total power is the sum of the two individual readings, shown by each meter.

The two phases have a common return in Fig. 2, but the total power will be the same as in Fig. 1. In making the two-phase 3-wire connection care must be taken to see that the lead not passing through the meter is the neutral wire. By employing two single-phase watt-hour meters as shown in Figs. 1 and 2, it is possible to meter the energy in two- or three-phase circuits. However, in a three-phase circuit when the power factor is less than 0.5 one meter will reverse and the total power transmitted in the circuit is the difference of the reading of the two meters and not their sum. This method has the disadvantages that two meters take up more space and are more expensive than one meter and two readings must be taken, with the possibility of error in reading the meters. The readings of a 3-phase circuit would have to be added algebraically which further would tend to allow a chance of error to be introduced. Therefore it is preferable to use a polyphase meter in which one set of dials gives the true power consumption.

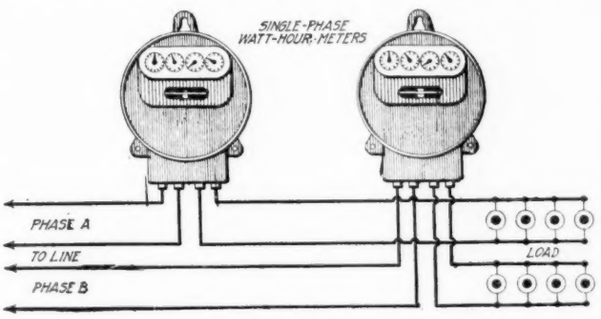

Fig. 1

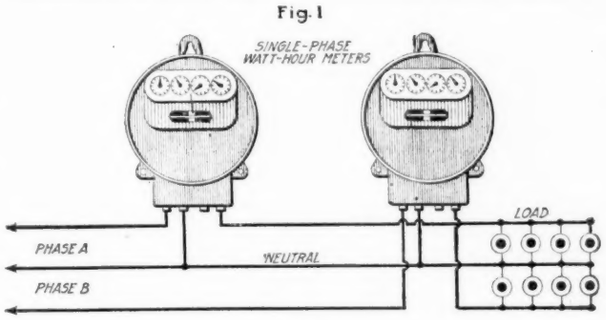

Fig. 2

FIGS. 1 AND 2. SINGLE-PHASE WATT-HOUR METERS CONNECTED ON A POLYPHASE SYSTEM

Polyphase watt-hour meters can be tested and also be employed on a single-phase two-wire circuit. Fig. 3 shows the connections for testing 2- or 3-phase 3-wire meters on a single-phase circuit. In the figure the switch *S* can be thrown so that either of the series coils is put into the circuit and each element is tested separately, but the full-load speed of one element (either upper or lower) should be half the normal full-load speed of the meter. It is important, however, that both shunt circuits are connected during all tests.

If two- and three-phase three-wire meters and two-phase four-wire meters are tested on a single-phase circuit, the current coils of the two elements should be connected in series and the two potential coils connected in parallel, and divide the calibrating constant by 2. For three-phase four-wire meters employing three coils connect all three current coils in series and divide the calibrating constant by four. In connecting a polyphase watt-hour meter in such a way as to operate as a single-phase meter, it should be remembered, that if the two series elements are connected in series with each other, the current must pass through each coil in the same direction so as to produce rotation (see Fig. 4). If connected as shown in Fig. 5 the two elements will buck each other and will result in no effective turning effort, provided the meter has been properly balanced. In using a polyphase watt-hour meter as a single-phase meter, connected as in Fig. 4, the indications will have to be divided by 2 to obtain the correct reading. The speed of the meter will decrease to about half the normal full-load speed, if only one of the two elements is employed, and would vary according to the energy consumed, consequently the meter will be direct reading. However, the use of one current and one potential coil might introduce an error if the meter elements were not balanced perfectly—that is, each set of windings develop one-half the torque on balanced load—therefore it is better practice to have the upper and lower elements combined.

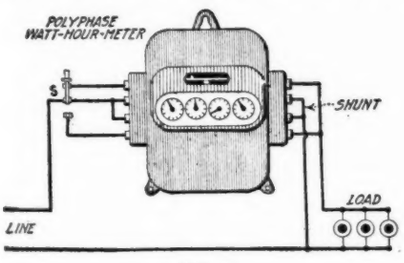

Fig. 3

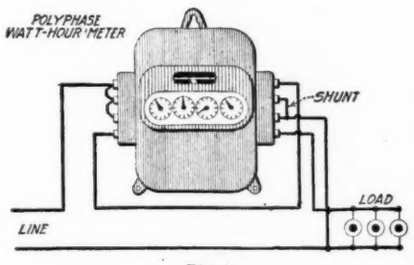

Fig. 4

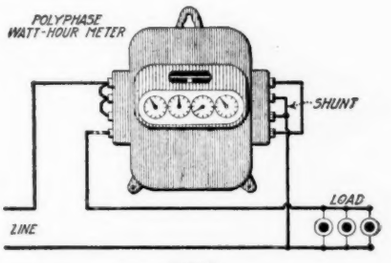

Fig. 5

FIGS. 3 TO 5. POLYPHASE WATT-HOUR METER CONNECTED ON A SINGLE-PHASE CIRCUIT

How Efficiency and System in a Power Plant Brought Its Chief a Better Job

By CHARLES L. BRUFF

JIM HARRIS was young and ambitious enough to tackle any kind of a job, but he could not help feeling the responsibilities of the one that had just been given him. That morning the "old man" had called him into the front office and told him his old "chief" could never be well again and that he was to have the job if he proved able to handle it. Jim knew he could do this for he had been keeping things running in good shape while the chief had been away. But he was not satisfied with this; he wanted to make a record and believed it could be done by cutting down costs in the plant.

Jim had for some time been planning in a general way what could and should be done to improve things, but now that it was "up to him" he was not quite sure of the best way to go about it. The new job had not swelled his head and he was not above asking for advice and taking it if he felt it was good and given in the right spirit. He had an old friend, Jack Walters, who had been through about the same mill a few years before, and who, he believed, could help him out with some good pointers. He had not seen his friend for some time as he had moved to another town, but he heard that Jack was more than making good and was on the road to the top with his company. In fact, Jack had always made good in every job he had held, and it had always puzzled Jim to account for his quick rise. They had gone to school together and began work about the same time, but Jack got his license first and a few years later was made chief of his plant. From this he had jumped to assistant superintendent of the factory and just a few months ago had been made superintendent of a new factory that had been built by the same concern. Jack had never been a special star at school nor had he shown any great mechanical talent, and as he had no "pull" his rapid climb up the ladder was hard to account for.

Jim decided to write his friend about the new job and ask for advice. He told Jack just how things stood in the plant: That the former chief had been a good fellow but not up to date, especially on power-economy methods, and that the factory manager seemed to care very little about what the fuel bills were as long as things ran all right, though a lot of money could be saved if he could be made to realize it and would stand for a small amount of expense for repairs and changes and for the instruments needed to find out exactly where the waste was taking place and what to do to stop it.

Jack's reply came promptly and started off by congratulating Jim on his promotion and wishing him success in his work.

"I appreciate your asking my advice," Jack wrote, "and whileI don't claim to be any shining example, perhaps I can give you a few tips that will help, for I have been through just what you are getting up against, and the methods I used seem to have worked out all right in my case and should in yours. Probably I can help you best in getting started along the right path by telling you my own story and how I went about saving money for the company by improving my plant. And that saving of money is just what started me going up to where I am today, because what any live concern wants in executive positions is not only a hustling producer—he has got to be that—but one that can produce at the lowest possible cost as well. It is true that savings in the power plant in fuel and materials take longer to show than savings in manufacturing departments, but if they are really there they are bound to show up and usually come out strong. I can see you have the right idea, that you have studied and are up to date in power-economy matters, so I won't go into details as to what I did in the plant, but will just give you the general plan on which I worked, reciting a few special cases to make things clear to you.

"My 'boss' did not know much about power plants, but he had a fairly good mechanical head. He surely was a business man and knew the value of a dollar as well as any man I ever saw. At the time he told me I was appointed chief engineer he gave me a good stiff talk, and some of the things he said certainly hit the mark. I have never forgotten them. He said he felt safe in turning the plant over to me because I had proved to his satisfaction that I knew my work and could be depended on. As long as I could keep things running right and keep the plant costs down where they were, the job was mine, but was I going to be satisfied with being an operating engineer all my life? You can bet I told him no, and that I expected to work myself up as far as my abilities would take me. Then he gave me one of the straightest tips I ever had in my life. 'It isn't all or even to a large extent a question of natural ability or of education that brings a man up the line' said he; 'it is the way he makes use of the ability and education he has. A man may have half a dozen university degrees and not be of half as much use in the business as the fellow with a high-school education and practical experience who has enough brains and common sense to put them to practical use. Remember one thing—in making your way in the world, it is not so much what you know that counts, but what you can let other people know that you know, in a way that will be of some value to them.

" 'Take your case: You are young and ambitious and no doubt have a lot of ideas about improving your plant that you would like to try out. Soon you will be com-

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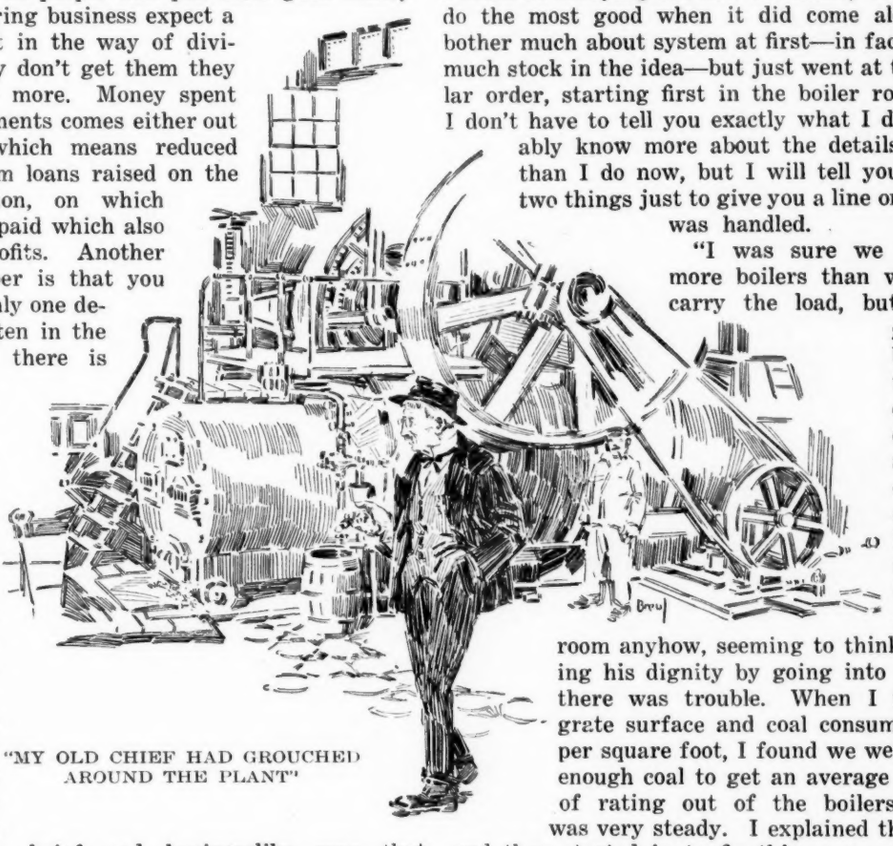
ing to me for money to buy new equipment and make changes with, and I hope you do. I will be disappointed in you if you don't, but when I turn you down on some of them, as I probably will unless your arguments are mighty good, don't get mad and nurse a grouch, for if you do you will be a quitter. Just tackle the job in some new way and come back at me again; that is, if you are sure you are right and it will be to the advantage of this concern to spend the money the way you suggest. You have got to look at my side of it as well as your own, so understand that the money that runs this business is not all mine to spend as I please, and if it were you can bet I wouldn't throw it away, anyhow. The people who put their good money into a manufacturing business expect a good return on it in the way of dividends, and if they don't get them they won't put in any more. Money spent on plant improvements comes either out of the profits, which means reduced dividends, or from loans raised on the concern's valuation, on which interest must be paid which also comes out of profits. Another thing to remember is that you are the head of only one department out of ten in the factory, and as there is only a limited amount of money that can be spent each year, I have to divide this up among the different departments so that it will be of the most benefit to the business as a whole.



"MY OLD CHIEF HAD GROUCHED AROUND THE PLANT"

"'Now you can see where the fellow that can tell me what he knows in such a clear, brief and businesslike way that he can convince me that he is right, comes in strong and can get things that the fellow who may know more but can't let me know it, can't get. First, be absolutely sure you are right, then work to convince me you are, and you stand a good chance of getting what you want if I can afford to let you have it. And don't forget that it isn't so much the number of hours a day you put in on the job that counts as it is what you accomplish during that time. You are now in an executive position in this organization, and the real executive, whether running a power plant or a million-dollar company, is the man who can lay out the proper amount and kind of work for the fellows under him and see that they do it and do it right. To do this you have got to have some sort of a system to work on, and it will pay you to study out a system for your plant and put it to work.'

"This talk from the 'old man' did me good and started me thinking along new lines. I remembered the times my old chief had grouched around the plant, cussing the boss and the company because he had been turned down on some pet scheme of his, and I began to wonder who was really to blame for our not getting the things we needed and if the chief had really put them up to the boss in the right way. He had certainly talked good common sense to me and seemed to be willing to do anything he could that was right for the plant, but it had to be proved to him that a thing was right before he would go ahead with it. After thinking it all over, I decided to see what could be done to improve the economy of the plant we had, by putting its equipment in the best possible shape and by getting the boys interested in economy work, before asking for any money for improvements. At the same time I figured I could be studying out how the money could be spent to do the most good when it did come along. I didn't bother much about system at first—in fact, did not take much stock in the idea—but just went at things in regular order, starting first in the boiler room, of course. I don't have to tell you exactly what I did. You probably know more about the details of this work than I do now, but I will tell you about one or two things just to give you a line on how the work was handled.

"I was sure we were running more boilers than were needed to carry the load, but the fireroom gang always balked on shutting one down, claiming they could not keep steam up without it, and the chief had backed them up. He never bothered much with the boiler room anyhow, seeming to think he was lowering his dignity by going into it except when there was trouble. When I figured up our grate surface and coal consumption per hour per square foot, I found we were burning only enough coal to get an average of 75 per cent. of rating out of the boilers and our load was very steady. I explained this to the gang and then started in to fix things so a boiler could be safely taken off. The settings and doors were leaking air, and these I soon got fixed up. After this was done, I found the damper regulator was shut about half the time, so one morning I had one of the fires banked. There was a kick, of course, but it took only a few hours' run to prove that the three boilers would carry the load as well as four and that their work was little if any harder in keeping up pressure. They had to pay more attention to keeping the fires in proper condition, which was what I was after, as with four boilers on it was a cinch to keep working pressure with any kind of firing. We were getting economical operation with no more actual work than there was when conditions were bad. I had a draft gage and flue-gas analyzer and went to work to get draft and fire conditions right, and when this was done the CO_2 jumped from about 6 per cent. to 10 per cent. and stayed there right along.

"I next went after the machinery, looking for steam leakage through valves and rings, and found plenty of it, though every unit was running like a clock so far as outside working parts were concerned. I had valves

and rings fixed up, but did not go after any reboring or new parts, though some were needed. I went over throttle and drain valves for leakage and made them tight, and then tested out all the steam traps around the factory and had them put in good shape. Some steam and hot-water pipes were not covered, and this I had fixed up as well as possible with what stock we had on hand. I felt that about all that was possible had been done without asking for money, and the work had cost very little as it had all been handled by my own crowd. We burned about seven hundred tons of coal a month, and as the factory output stayed fairly uniform the coal bill had been started, the same each month for over a year. At the end of the first month after the patching up and combustion work had been started, the coal consumption dropped off about twenty tons. I said nothing about it, neither did the Boss, but I went after things harder than ever. At the end of the next month there was a further drop of thirty tons, and then he sent for me. 'You must be getting a good lot of coal now,' he said. 'I see you used only 650 tons last month and it used to run around 700.' I said it was good coal, but about the same we had been getting right along. 'Then how do you account for the coal figures?' he asked. 'The factory has been turning out just about the same amount of stuff as before.' Then I told him what had been done in the plant, and he grinned and said: 'I knew all the time what was going on, and you have the right idea. Keep after things, but don't forget what I said to you about putting a system to work.' He did not hand me any bouquets, but next pay day my envelope was quite some fatter than it had been before.

"I NEXT WENT AFTER THE MACHINERY"

"After a couple more months' running with the fuel bill staying about the same, as far as I could see we had done everything we could without spending money for outside help and new equipment, with which I was sure we could knock off at least another fifty tons a month, and it seemed about time to strike for what we needed. There were two ways of doing this: One was to give the boss a list of what I wanted all at once and tell him what it would cost, and the other was to put these things up to him one or two at a time. Remembering what he had said about having only a limited amount to spend at any one time, I decided on the latter course, though it meant delay in getting the savings I was after, and I picked out the most important things to go after first. Now I could go to him personally with these things and talk his ear off if he would listen, or I could get my figures down on paper and give him a brief estimate on the cost of a job or equipment wanted and an estimate on what it would save, and let him look it over and send for me if he wanted to talk about it. The latter method seemed to me the right one, and I tried it. I just gave him a safe figure on cost, a conservative estimate of savings and a brief statement of why and how the saving would be obtained, avoiding any windy arguments and technical stuff as far as possible. He seemed to like the method for I got a lot of things asked for, and most of them made good, because I had played pretty safe on my estimates. When a recommendation went in on paper, I knew it was a permanent record and would come up and kick me some day if my estimates were wrong or if what was bought did not turn out all right, so I was careful. The fuel bills kept on dropping and so did bills for oil, packing and other materials, and after a while the plant was running with a smaller force, though the fellows that stayed were making more money.

"You can imagine that doing all this inspecting, overhauling and fixing up, as well as regular routine work, kept me mighty busy. In fact, I put in from twelve to fourteen hours a day on the job during the first six months, and there did not seem to be much prospect of things easing up if we were to keep on getting economical results. I had no time for reading up on new things, hardly got a chance to even look over the engineering magazines I always subscribed for, and in spite of the time put in on the job there always seemed to be something that had been overlooked that would cause trouble. I liked the job, but was not satisfied to spend the rest of my life at it and could not see how to get any further along unless I could find more spare time for study. I used to wonder how it was the 'old man,' who had twenty times as much to think about and handle, could come down to the office at 8:30 every morning and leave before 5 at night, and yet manage to keep in touch with everything going on. Then I remembered what he had said about system in working, and it struck me that must be the answer, but I could not see how it would apply in my case. One day I spoke of this to our chief clerk, and he said right away that it was the answer and that system could be applied to any kind of work. I told him how hard it was to be sure of following up all the details of the power equipment in plant and factory, and he offered to show me how it could more easily be done.

"YOU MUST BE GETTING A GOOD LOT OF COAL NOW"

"You know what a 'tickler' card file is, don't you? Well, he gave me one of them, with a bunch of cards, and showed me how it was used by office executives in following up work. The cards were indexed so as to give a set for daily routine work, one card, or more if necessary, for each day of the week, filed under Mon-

day, Tuesday, etc. Then there was a weekly set, indexed as first week, second week, etc., and then a set indexed under names of the months. There are certain jobs that should be done each day to keep things going right, and these are listed on the daily cards and checked off when you have seen them done or they are reported as done. The same cards are used for jobs done less frequently but on certain days of the week. The things done weekly or every second or third week are put down on the weekly cards and checked off when done. When all jobs on a card have been checked off as done, this card is moved back in the file to the next day or week that the jobs are again due on, and the same general method is used for following up monthly jobs or those to be done only once or twice a year at a certain time, using the monthly cards for these. If a job must be put off for any reason, its card is moved back to the next day, week or month, as the case may be, and taken up then. You can see what this system means to a busy engineer, after its details are once worked out and it is operating right, can't you? Instead of being worried all the time for fear he has overlooked something that may cause trouble or be wasting money, he knows at a glance just what has been taken care of, and what work has to be done for days, weeks and months ahead, barring, of course any breakdown or special repair jobs. He also has a permanent record of his work.

"I had to work out the details of the system for the plant, and it took some trying out before I got the jobs spread out over the right length of time, and coming on the right days or weeks; but it was not a hard matter to do this, and when it got working right it certainly took a load off my mind. I soon found that each day there would be certain regular jobs for each man in the gang and if any of them were tied up on special work it was not hard to shift these jobs to other men or put them off for a day, but the greatest thing about it

"NEXT PAY DAY MY ENVELOPE WAS QUITE SOME FATTER"

was that nothing was overlooked and each man knew what he had to do and when to do it. I had to follow some of them up at first to see that they really did the work, especially on inspections, but after they found out I meant business there was very little trouble.

"After the system had been in use for several months, I began to find spare time on my hands during working hours. I could put in this time reading engineering magazines and technical books or in talking to salesmen, who often gave me a lot of good dope even outside the lines they were handling. I could also spend more time thinking out new ways of improving the plant and saving money and in putting these matters up to the boss in the best way. It was a surprise to me how this system of working, and especially the inspections, cut down our repair costs. We hardly ever had a breakdown; troubles were located and stopped before they got that bad.

"Well, Jim, that is about all there is to say. After the first year I found I could go home almost every

"I COULD GO HOME ALMOST EVERY NIGHT ABOUT THE TIME THE BOSS DID"

night about the time the boss did, feeling quite easy in my mind, for I knew there was little chance of anything serious happening. I had my evenings free and took a course in factory management, and that, with the information picked up in going around through the works, gave me a fairly good knowledge of the business in general. Three years ago, when Brown, the assistant superintendent left, the boss gave me the job.

"If I were in your place, just taking hold of a power plant again, I would work about as outlined, but would go about it in a somewhat different way. If I knew the plant and the fellows in it well, as you do, I would first make them understand that we were out to cut expense for fuel and supplies by making better use of them, and try to make them see that it was to their advantage to do this, because a saving made in cost of materials would probably mean more money for those who effected it. Then I would fix up the plant as well as possible with the help of its own gang and start right away to work out a system of taking care of things, giving each man certain things to do at regular times and covering every detail that needed looking after, and then make it your business to see that they do the work assigned to them. It might be a good thing to ask your boss for the testing instruments you need, and if your arguments are strong enough you will probably get them. But if you do, make use of them; don't let them lie around on the shelf for ornaments or you won't get the other things you want. When you once get things in shape, it won't be long before the savings will begin to show up and then you can strike for money for improvements. Be sure, though, you know what you want and can prove its value, for one failure may do more harm than can be offset by several things that make good. You can't be a 'stand patter' if you want to get ahead, but you can't afford to be too enthusiastic and try to get money for anything that comes along that looks good."

Did Jim Harris follow his friends advice? He did. Did he make good? Well, if you knew his boss well enough to ask him who was next in line for promotion in his factory, he would tell you, Jim Harris.

The Absorption Refrigerating Machine—II

By H. J. MACINTIRE
Professor of Mechanical Engineering, University of Idaho

Tells the operating engineer those things he should know to operate successfully the absorption refrigerating machine.

PROPER conditions of operation are necessary to good results in the use of both the compression and the absorption machine. Too high a suction pressure will destroy useful refrigerating effect for the compressor; for the absorption machine, unless the generator distills off the ammonia properly and the absorber provides the necessary *stronger* aqua, the concentration of the aqua in the generator will not be maintained, and poor refrigeration will result. With the compression machine it is only necessary to operate with a proper suction pressure to get the desired refrigeration, but with the absorption machine the aqua must be of the proper average strength, the steam pressure must be high enough, the absorber must give aqua of high enough strength and the aqua pump must be operated at a desirable speed. This seems complicated, but it really is not so, as will appear in what follows.

TABLE I. TEMPERATURES, PRESSURES AND CONCENTRATIONS FOR AQUA AMMONIA

Pressure on Aqua in Pounds per Square Inch Absolute

*	10	15	20	25	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
2	169.0	189.4	206.5	220.0	231.1	249.4	264.3	277.9	288.8	299.0	307.8	316.2	323.7	330.7								
4	161.0	180.8	197.5	210.5	221.9	240.3	255.0	267.7	278.9	288.6	297.3	305.6	313.4	320.3								
6	153.0	172.3	188.8	201.5	212.4	229.5	244.0	258.0	269.0	278.5	287.4	295.3	302.6	309.6	316.0	322.2						
8	143.5	164.2	180.1	193.1	203.7	221.4	236.0	248.2	259.0	268.5	277.3	285.1	292.5	299.6	305.8	311.6						
10	137.4	154.3	171.1	183.7	194.6	212.3	227.0	239.6	250.5	259.5	267.9	275.8	282.9	289.4	295.7	301.8	307.4	312.6				
12	129.0	147.8	163.1	175.1	185.5	203.3	217.2	229.2	240.0	249.4	258.1	265.6	272.7	279.7	285.6	291.5	297.0	302.2				
14	120.5	140.1	155.5	167.4	177.6	195.2	209.1	220.8	231.2	240.5	248.9	256.1	263.0	269.7	276.0	281.8	287.3	292.4	297.1	302.0		
16	113.0	133.0	147.4	159.3	169.4	187.1	200.5	212.0	222.3	231.6	239.9	247.3	254.0	260.4	266.4	272.2	277.5	282.8	287.3	292.0		
18	107.5	124.9	139.4	151.4	161.2	178.3	192.0	203.1	213.5	222.6	230.9	238.0	244.7	251.0	257.0	262.5	268.0	273.0	277.6	282.4	287.0	291.7
20	99.0	117.3	132.0	143.6	153.8	170.2	183.6	195.4	205.0	213.8	221.8	229.1	235.9	242.0	247.9	253.5	258.6	263.6	268.4	273.3	278.0	282.7
22	92.0	109.9	124.6	139.9	146.0	162.7	175.9	187.0	196.9	205.6	213.5	220.6	227.1	233.4	239.3	244.7	250.0	254.9	259.3	263.9	268.5	273.0
24	86.0	103.0	117.0	129.5	139.2	155.2	168.7	180.0	190.0	198.4	206.0	213.0	219.2	225.5	231.3	236.7	241.9	246.7	251.0	255.5	260.0	264.5
26	79.2	96.3	110.6	122.1	131.9	148.2	161.0	172.1	182.0	190.7	198.2	205.1	211.5	217.6	223.4	228.7	233.7	238.4	243.0	247.2	251.5	255.8
28	73.4	90.6	103.6	115.3	125.0	140.6	154.0	165.2	174.7	182.8	190.3	197.1	203.1	209.3	215.0	220.4	225.5	230.3	234.5	238.9	243.2	247.5
30	66.5	83.8	97.0	108.5	117.8	133.5	146.1	157.0	166.4	174.9	182.7	189.4	195.6	201.3	206.9	212.2	217.3	222.0	226.7	231.1	235.1	239.3
32	61.0	76.9	90.0	101.0	111.0	127.1	139.4	149.7	158.8	167.3	175.0	182.0	188.2	194.0	198.4	204.5	209.4	213.8	217.7	222.0	226.4	230.8
34	55.0	71.6	84.0	94.8	104.5	120.0	132.0	142.4	151.9	160.2	167.8	174.6	180.9	186.6	191.9	197.0	201.7	206.1	210.0	214.2	218.3	322.5
36	49.0	65.5	78.5	88.8	98.1	113.5	125.8	136.0	145.3	153.3	160.7	167.3	173.5	179.3	184.7	189.7	194.5	199.1	202.9	206.8	210.6	214.4
38	43.0	60.0	72.5	83.2	91.8	106.8	119.4	130.0	138.7	146.7	153.8	160.3	166.4	172.2	177.5	182.5	187.3	191.7	195.6	199.3	203.0	206.9
40	37.0	53.8	66.0	77.3	86.0	101.0	112.9	123.4	132.3	140.0	147.0	153.4	159.4	165.0	170.5	175.5	180.1	184.6	188.9	192.8	196.5	200.1
42	31.6	48.7	61.0	71.5	79.4	94.0	106.3	116.4	124.9	132.5	139.8	146.4	152.7	158.2	163.5	168.5	173.3	177.7	181.4	185.3	189.2	193.0
44	27.5	43.2	55.3	65.3	73.6	87.8	100.1	110.3	118.8	126.3	133.4	139.9	146.0	151.5	156.7	161.6	166.3	170.8	174.3	178.2	182.0	185.0
46	21.2	37.6	49.7	59.6	68.1	82.0	94.0	104.2	112.8	120.1	126.9	133.4	139.5	145.0	150.2	155.0	159.4	163.8	167.5	171.3	175.2	179.9
48	16.0	32.0	44.4	54.2	62.7	76.7	88.3	98.5	106.7	114.0	120.6	127.0	132.9	138.4	143.7	148.6	153.3	157.5	161.2	164.9	168.6	172.5
50	11.0	26.8	38.9	48.4	56.8	70.9	82.6	92.6	100.8	108.3	114.9	121.0	126.9	132.4	137.2	142.0	146.4	150.7	154.9	158.7	162.4	166.0

* Concentrations

Suppose we have a generator containing aqua of 26 per cent. (26 per cent. by weight of ammonia and 74 per cent. by weight of water) concentration. Suppose also that a condenser pressure of 161 lb. gage is carried (this is determined by the amount and temperature of the cooling water), such a solution at this temperature and condenser pressure will boil at 245.5 deg. F. This is similar to the action of heat on pure water. We say ordinarily that water in an open vessel will boil at 212 deg. F.; also that the temperature of the water (and steam) in a boiler at 125 lb. gage is 353.1 deg. F., and the temperature of steam under a vacuum of 26 in. is about 153.0 deg. F. In other words, when speaking of saturated steam, there is a definite, unvarying pressure for each particular temperature. This is also true for anhydrous ammonia, but aqua ammonia is different, because there is water present, varying in amount from 70 to 80 per cent. But if we have a certain concentration and a certain pressure, then the solution has a maximum concentration at a certain particular per cent. That means that at 26 per cent. under the pressure of 161 lb. and a temperature of 245.5 deg. F., there could not be any more ammonia dissolved. In other words, a saturated concentration at 26 per cent. and a condenser pressure of 161 lb. will have a temperature of 245.5 deg. But more important than this, if the pressure is 161 lb. and a temperature of 245.5 deg. F. is maintained, a concentration greater than 26 per cent. will cause some ammonia to be driven off as a gas. If the solution was 27 per cent. or 28 per cent. or 30 per cent., then while the temperature and pressure are maintained constant, a boiling action would continue until the remaining solution has a strength of 26 per cent. This is true of any solution of ammonia and water; that is, there is a certain fixed relationship of the pressure, the temperature and the saturation concentration, and if any two are known, the third may be found, as will be seen from the table.

Such being the theory of the action of the generator, let us see how the action is accomplished. In the generator steam coils are provided, so arranged as to supply the heating surface necessary to drive off the ammonia gas and steam. This is somewhat similar in manner to the case of a steam boiler. In a water-tube boiler we usually say that 10 sq.ft. of heating surface is required per boiler horsepower. In the generator 14 or 15 or 16 sq.ft. of heating surface is used per ton of refrigeration. Of course in the generator we could use very hot steam in the heating coils—say steam at 75 lb. or 100 lb. pressure—and in consequence of such intense heat (comparatively) the heating surface could be cut down to 12 or 10 or even to 8 sq.ft. Nowadays, however, the demand is only for low-pressure (exhaust) steam absorption machines. In the case cited it might be desirable to boil the solution down to 22 per cent. (requiring a temperature of the aqua of 262.1 deg. F.), and as a mean concentration of 26 per cent. would be used, then 30 per cent. concentration could be looked for in the strong aqua. The steam pressure must be such as to give a sufficient temperature difference between the steam in the coils and the

aqua. For example, 262.1 + 10 deg. = 272.1; that is, a 28-lb. steam pressure is required.

The action then of the generator is to boil off a vapor which is a slightly superheated ammonia. This is obtained by having a temperature sufficiently great in the steam coils, determined by means of the values given in the table. Increasing the steam pressure or decreasing the head pressure or increasing the concentration will stimulate the boiling action, but the easiest means of control in the hands of the operator is the steam pressure. If capacity is not being obtained, a rise of steam pressure will give hotter steam, therefore a greater temperature difference and a greater heat transfer. The result will be that more steam will be condensed in the coils and more ammonia gas will be distilled out of the generator.

It is readily seen from the foregoing that one of two things in the generator may be wrong if the plant is found not to condense the ammonia properly—either there is too weak a concentration in the generator or the steam pressure is too low. In either case charging more anhydrous into the system or increasing the steam pressure will give the same results; namely, having enough difference between the condensing temperature

TABLE II. POUNDS OF STRONG AQUA REQUIRED PER POUND OF AMMONIA EVAPORATED

Concentration Weak Aqua	Concentration—Strong Aqua—							
	20%	22%	24%	26%	28%	30%	32%	34%
18%	41	20½	13¾	10¼	8.2	6.84	5.86	5.12
20%	..	40	20	13⅓	10	8.0	6.77	5.71
22%	..	...	39	19½	13	8.75	7.8	6.5
24%	..	...	...	38	19	12⅔	9½	7⅗
26%	..	...	...	...	37	18½	13⅓	9.25
28%	..	...	...	...	....	36	18	13.0

of the steam and the boiling temperature of the aqua to enable sufficient heat to pass through the heating surface of the steam coils. All of this may be seen from the table. For instance, suppose it is found that ammonia is not being condensed fast enough in the condenser, though the latter is working properly and the rectifier is not cooling the gas too much. Suppose the steam temperature is 250 deg. F. and the condenser pressure is 161 lb. It is possible to take a sample of the weak aqua and test it for its concentration. This, however, is not really necessary if we have a means of measuring the temperature of the aqua as it leaves the bottom of the generator. Suppose the temperature is 245 deg. F. Referring to the table, the concentration is found to be only 26 per cent. If this concentration had been 28, then it is evident that boiling of the ammonia would have occurred at a lower temperature (237.1 deg. F.), more pounds of ammonia would have been evaporated. The same result necessarily would have occurred with an increase of steam pressure.

The action of the absorber is somewhat like that of the jet condenser, and reference to a few of these similarities may make the subject clearer. In a steam condenser the vacuum (or back pressure on the turbine) is produced by condensing the vapor. The total pressure exerted is the sum of the vapor (steam) pressure and the air pressure. This air pressure accumulates and has to be removed by means of an air pump, or the vacuum would be lost. In a similar manner the back pressure or boiling pressure of the ammonia in the brine cooler on the expansion piping is determined by the action in the absorber. The slightly superheated gas from the expansion coils passes into the absorber and is allowed to come in contact with a spray of weak cold aqua, or is allowed to bubble up in the aqua. Since the aqua is not pumped away as the water is in the jet condenser, the heat of condensation and of solution has to be taken away by an outside medium, which in this case is the cooling water used. But, as in the case of the surface or jet condenser, the total pressure in the absorber is equal to the pressure due to the vapor tension plus that due to air or inert gases present.

The vapor tension in the absorber is determined by the temperature and concentration of the strong aqua in a manner similar to that used in the case of the generator. For example, if the strong aqua is 90 deg. F. and 32 per cent. aqua is being carried, then the vapor tension is (from the tables) 20 lb. abs., or 5 lb. gage. But this 5 lb. gage is possible only when the absorber is purged out. A new plant is likely to have a large amount of air in the system, and this will slowly accumulate in the absorber. If air collects, which will itself exert a pressure of 3 lb. per sq.in., then the total pressure in the absorber will be 8 lb. The pressure at which boiling of the ammonia takes place is not the absorber pressure. It tends to become this pressure, but in fact there is usually considerable "wiredrawing" between the two pieces of apparatus, and the result is that the pressures of the brine cooler or expansion headers are usually from two to five lb. in excess of the absorber pressure. This last loss of pressure may be eliminated by making the pipe-line connections and gas headers of liberal size. The inert gas may be removed in a manner similar to that used in the ammonia condenser.

Effect of Temperature of Cooling Water on Operation of the Plant

Reference to the table also shows the effect of the temperature of the cooling water on the operation of the plant. For instance, the absorption machine finds its particular sphere of action in low-temperature work. A strong aqua of 32 per cent. concentration and at 5 lb. gage must be cooled at least as low as 90 deg. F. If the temperature of the water rises so that the aqua is kept at 97 deg. F., then the aqua concentration (see table) will be 30 per cent. instead of 32. Usually, the absorption machine operates under small differences of concentration, like 22 per cent. to 26 per cent. If the machine had been designed for operation between 26 and 32 per cent. and the aqua fell in concentration to 30 per cent., the aqua pump would have to be speeded up and the steam economy in the generator (as well as the economy of water used in the absorber) would be decreased.

The reason for the last statement may be seen on examining the action of the strong-aqua pump. This pump has a function similar to the boiler-feed pump which takes the feed from an open feed-water heater. But the strong aqua is only a carrier—a pound of strong aqua has a little (sometimes a very little) more ammonia absorbed in it than does the weak aqua entering the absorber. This strong aqua carries back to the generator the ammonia absorbed in the absorber. Therefore, if it takes 12⅓ lb. of strong aqua to carry back one pound of ammonia, a drop in concentration from 32 to 30 per cent. would necessitate pumping 18⅔ lb. of aqua, or one-half more than before. So, evidently, it is important to keep the strong aqua as strong as possible, and for satisfactory operation of the plant a means of getting the strong-aqua temperature as it leaves the absorber should be provided. If no inert

gases are present, then the concentration may be obtained from the aqua tables corresponding to the temperature and pressure. The effect of the concentration on the action of the pump may be seen from Table II.

The Difference in Concentration Should be Kept as Great as Possible

Generally speaking, it is wise to keep the difference in the concentration as great as posssible. The reason for this is that the weak aqua has to be cooled by cooling water before admitting it to the absorber, and also the strong aqua has to be returned to the generator at a temperature much below the temperature of the aqua there. This latter action is as bad for economy as is the pumping of cold water into a steam boiler. For before the ammonia can be distilled, the aqua must be heated up to the temperature of the solution in the still. If a very little aqua is circulated (large differences of aqua concentrations being used) then this loss is small, but if a large amount of aqua is pumped the loss is appreciable and should be corrected.

In conclusion, it is recommended that the operating engineer operate the absorption machine by reference to a table on the properties of aqua ammonia. If he is equipped with suitable means for securing the necessary temperatures, the concentrations are easily found. If thermometer wells are not provided, he can improvise a substitute by making a "pocket" for oil on the outside of the pipe, into which the thermometer may be placed for approximate temperature determinations. He should remember that the absorber gage and the condenser gage show the total pressure, but that the ammonia pressure is a "partial" pressure less than that shown. Finally, he must remember that the concentration must be maintained and the pump action must be satisfactory to get desirable operation.

Flywheel Effects of Synchronous Motors

By W. T. Berkshire*

Synchronous motors driving air or ammonia compressors or other reciprocating apparatus embody, in the most essential respects, the same factors as engine-driven generators, so far as synchronous operation is concerned. Whether a synchronous machine is operating as a generator or as a motor, it behaves in the same manner as regards stability. That is, if its rotor is pushed or pulled away from the stable position in rotation—whether this be at no load or full load—there is a force opposing such displacement that is practically proportional to the displacement. Hence, if a variable torque is imposed upon the shaft, either positive or negative, that is, either generator or motor operation, there will exist the tendency toward instability.

An air or ammonia compressor is a reciprocating machine of relatively large mass, and therefore has a turning-effort curve which in a general way resembles that of reciprocating engines. The variations are periodic and of sufficient magnitude to cause the motor to oscillate if proper precautions are not taken. The precautions consist in the use of flywheel weight sufficient to limit the periodic angular deviation to 3.5 electrical degrees in either direction from the position of uniform rotation, and to fix the natural oscillating frequency at a safe distance from the frequency of the forced impulses of the compressor. The two most important impulses have frequencies equal to the revolutions and to the strokes of the compressor, and it is considered desirable to keep the natural frequency of the motor away from the revolutions or strokes by 20 per cent.

For any given unit the natural oscillating frequency of the rotor can be changed by changing the flywheel effect, as shown by the relation,

$$F = \frac{35{,}200}{S}\sqrt{\frac{P_o \times f}{WR^2}}$$

where

F = Natural oscillating frequency in beats per minute;

S = Revolutions per minute of motor (direct connected);

f = Motor frequency in cycles per second;

WR^2 = Total flywheel effect in 1 lb. ft.^{2} (rotor and flywheel);

P_o = A factor depending upon the synchronizing force of the motor.

This formula may be used as a guide to avoiding values of flywheel effect which, on account of resonance, or near resonance, of the natural oscillating frequency with the forced compressor impulses, would likely result in serious hunting trouble. The formula does not give the WR^2 necessary to limit the periodic displacement to 3.5 electrical degrees. This can be determined only from data that the compressor builder has at his disposal.

*Alternating-current Engineering Department, General Electric Co.

Preventing a Roll of Tape from Unwinding

By B. A. Briggs

A roll of linen tape is something that must be handled with care when taping a coil, for if it is let fall it will probably result in a tangle. One method of, to a degree, preventing the roll from unwinding so easily is to paint on both sides two stripes about one inch wide with shellac or paint, at right angles to each other, as in Fig. 1. This, however, leaves hard spots on the edges of the tape.

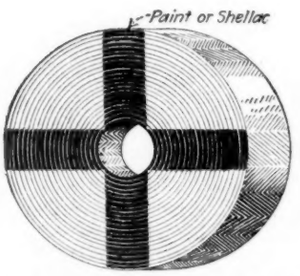


FIG. 1. PAINT OR SHELLAC STRIPS ON ROLL OF TAPE

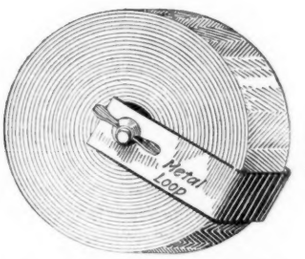


FIG. 2. METAL LOOP IN PLACE ON ROLL OF TAPE

Another method and one that does prevent unrolling of the tape except under tension is shown in Fig. 2. This consists of a loop made of thin spring steel bent so that the ends can be held at the center of the roll by a bolt. The necessary amount of pressure on the roll to prevent it from unwinding except when the tape is under tension is obtained by tightening the wing-nut until the desired result is obtained.

Economical Repairing of Starting Boxes

By E. C. PARHAM

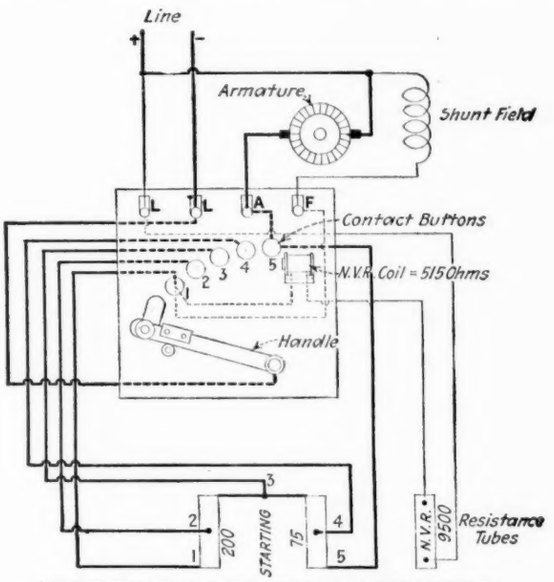
Methods are given for obtaining and keeping records to enable the repairman to intelligently make repairs on starting rheostats. The results of wrong connections are also discussed.

IN MAINTAINING a large number of starting rheostats of different types, makes and dates of manufacture, the more correct information available in regard to their various parts the more promptly and economically will it be possible to make the repairs and return them to service. Nearly all manufacturers have a general construction scheme running through a certain line of starters, and acquaintance with this scheme may mean the repairing of a starter from the hopeless remains of others of perhaps entirely different ratings. For example, several sizes of starter may include resistance tubes of the same rating, but which may be grouped in different combinations of series and parallel connections. On starters, the no-voltage release coil of which is connected in series with an independent resistance tube, frequently will it be found that the no-voltage coils and their resistance tubes are interchangeable on several sizes of starters of the same voltage. However, similarity of appearance and dimensions of these parts is by no means an indication that they may be used one for the other—their electrical characteristics may be widely different. On starters, the no-voltage release coil of which is intended to be connected in series with the shunt-field winding of the motor, the no-voltage release coil must be wound with wire that is able to safely carry the shunt-field current, the values of which differ widely on motors of different sizes. Owing to their being wound with wires of different characteristics, resistance tubes that appear to be the same may be entirely unlike as regards resistance values and current-carrying capacity. Very little can be assumed as to appearance where the resistance wire is embedded in cement or in enamel.

Not infreqently chances are taken in the emergency repairing of starting boxes, and in many cases these chances are temporarily a profitable investment; but such practice should be the exception. In order to make the repairs intelligently without depending upon the manufacturer, measurements of resistance must be made and coil groupings checked and records kept; otherwise the repairman will frequently find himself at a disadvantage.

Fig. 1 shows the information desirable to keep in card form for each starter that is sent in for repair. The manner of getting the information is as follows: The panel is lifted from the box without disturbing the connections. Then beginning with the active button nearest to the "Off" position, tag the tap that is connected to that button, No. 1, each succeeding tap toward the "Full-On" position being tagged with the next higher number. This tagging before disconnecting is absolutely essential, if confusion is to be avoided, because the taps are not always brought out of the resistance in the order in which they are connected to the buttons, and the coil arrangement on some starters is much more complicated than that shown in Fig. 1.

Having tagged the taps, the battery of resistance tubes may be removed for inspection and for resistance measurement with a Wheatstone bridge or some other method. The first resistance section is included between taps 1 and 2; the second between taps 2 and 3 and so on; the first column of Fig. 1 designating the sections. Next measure the resistance included between taps 1 and 2, 2 and 3, etc., until all sections have been measured, in each case putting the resistance value opposite the section to which it belongs, as indicated in the second column of the figure. Finally measure the resistance between taps 1 and 5; this resistance value should equal the sum of the resistance of the individual



SECTION	RESISTANCE	NO. TUBES	RESISTANCE PER TUBE	MFG'S. MARK
R1-R2	105	½	205	200A
R2-R3	100	½		
R3-R4	38	½	75	75A
R4-R5	37	½		
R1-R5	280	2		
N.V.R.Res.	9500	1	9500	9500
MANUFACTURER		SERIAL NO.	SIZE / TYPE	VOLTS

FIG. 1. CONNECTION AND RECORD SHEET FOR SMALL-SIZE STARTER

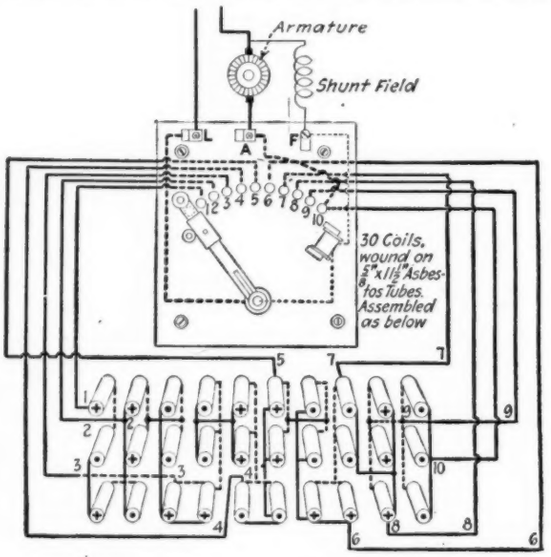
sections. In no case should the resistance of any section exceed that of the section nearer the "Off" position.

In column 3 is given the number of tubes or, in this case, the fractional part of a tube in each section. In starters of greater capacities, as will be indicated later, some sections will include whole tubes in series; other sections will include combinations of tubes in parallel. In column 5 is found the markings used by the manufacturer; such markings are used in ordering new tubes.

In event of the interior of the box being so badly burned as to destroy the identity of coils and taps, the only thing to do is to order an entirely new set of coils from the manufacturer, from which standard information can be obtained. Such of the old coils as are worth saving should be suitably marked and stored for making future repairs. Should measuring of the section resist-

ance disclose confusion of taps—a condition that easily may account for the failure of the starter—the taps and tagging should be investigated as follows:

Calling the end nearest the "Off" position tap No. 1, separate the coils, if necessary, so that the circuit through the resistance to the last tap can be traced by eye. Then beginning at No. 1 end and in consecutive order mark the intermediate taps No. 2, 3, etc. to the highest number, which in this case will be No. 5. On some starters the No. 1 end may be easily identified by the fact that only series tubes will be included in the first resistance section, while those sections near the "Full-On" position will include series parallel or parallel combinations of tubes. The sections of higher



SECTION	NO. TUBES	CONNECTION	RESISTANCE	RESISTANCE PER TUBE
1-2	4	Series	7.80	1.95
2-3	6	3 Se. x 2 Par.	4.85	3.23
3-4	4	2 " x 2 "	3.30	3.30
4-5	4	2 " x 2 "	3.30	3.30
5-6	2	2 Parallel	1.70	3.40
6-7	2	2 "	1.00	2.00
7-8	2	2 "	0.95	1.90
8-9	3	3 "	0.74	2.22
9-10	3	3 "	0.66	1.98
1-10	30	30 Ser-Par.	24.30	

MANUFACTURER	SERIAL NO.	SIZE	TYPE	VOLTS

FIG. 2. CONNECTIONS AND RECORD SHEET FOR MEDIUM-SIZE STARTER

resistance always should lie at the No. 1 end of the assembly. The investigation of the taps may show that the tags have been wrongly placed, in which event they should be changed and all section resistance again measured and recorded. As a final check the resistance from tap No. 1 to each of the other taps should increase in the order of the numbers.

Fig. 2 gives full information in regard to a 10-hp. starter composed of 30 resistance coils wound on asbestos tubes and having 10 taps. Assuming current to enter the resistance on tap No. 1 and to leave on tap No. 10, it will be noted that in passing from tap No. 1 to tap No. 2, 4 tubes are in series; from taps No. 2 to No. 3, two parallel paths of 3 tubes in series are passed through; from No. 3 to 4, two parallel paths of 2 tubes in series; from No. 4 to 5, the same as from 3 to 4; from No. 5 to 6, 6 to 7, and 7 to 8, 2 tubes in parallel. The tubes included between 5 and 6, however, being different from those included from 6 to 8, as indicated by the different values of resistance as recorded in columns 4 and 5 of the table. From taps 8 to 9 and from 9 to 10, three tubes are in parallel, but these are of two different kinds as indicated by the fact that the tubes of sections 8 to 9 measure 2.22 ohms each, and those of section 9 to 10, 1.98 ohms each. These measurements were taken from a box that had been in use for several years and which had been sent in on account of the no-voltage release coil having been burnt out as the result of a ground in the motor's field coils.

I have never experienced any trouble with either the tap-tagging or the coil assembling of resistances received from the manufacturer and have had to do with hundreds of starters. However, the interchanging of taps and the installing of coil assemblies end for end in the containing cases appear to be characteristic of starters that have been repaired a number of times by miscellaneous workmen unacquainted with the exacting conditions of the work. Once an error in tagging or connecting is made, it is likely to be repeated whenever the starter is repaired, unless systematic measurements are taken to prevent it.

Assuming for example that the assembly is correct and that all taps have been brought out in consecutive order, if the assembled tubes as a whole are installed end for end in the case, thereby bringing tap No. 1 over to the "Full-On" side of the panel, the operator is apt to connect the first tap to the last button and the last tap to the first button, the intermediate taps being connected consecutively but in reversed order. Such a connection will start the motor on the first button with the usual impulse, because the total amount of resistance on the first position will be the same as if the coils were correctly connected, the current entering the last tap and leaving by way of the first, thereby including the whole resistance. But on subsequent taps the resistance will be cut out in increasing increments instead of in decreasing ones. Therefore no speed increase may be noticed on the first few positions of the starting handle. As the handle approaches the "Full-On" position the resistance will be cut out in large units, causing the speed to accelerate in impulses that may result in the throwing off the belt and cause the brushes to spark to a degree depending on the connected load and on the size and design of the motor. Such a condition may persist for months if the operator is not particular as to how a machine should behave and the connected load is light. If the load to be started is heavy, the resistance sections that are near the "Full-On" position are likely to burn out, because they are composed of conductors of comparatively small current-carrying capacity and remain longest in the circuit, when they should be cut out on the first positions of the starter handle. This can be seen from the tables of Figs. 1 and 2. In connection with the starter, Fig. 1, which has only 5 notches, 37 per cent. of the resistance is cut out on the second button. In connection with the 10-hp. starter, 32 per cent of the resistance is cut out on the second button.

Too much care cannot be taken in the matter of keeping such records as will enable a repairman to restore every starter to its original condition; not only is such precaution a vital factor in determining the useful life of the starter itself, but it is a vital factor in determining the life of the motor and in insuring the continuity of its operation.

The Boiler Blowoff

By CHARLES L. HUBBARD

Facts relating to boiler blowoff pipes and connections that every engineer and fireman should know. Practical suggestions regarding the installation of such piping, protection of same and how it handles the blowoff valves are given.

EXPERIENCED engineers have proper respect for the blowoff pipe and connections. Every engineer and fireman should bear in mind that the various boiler connections are under the same pressure and should be installed and handled with equal care. Although the actual number of defects in blowoff equipment may not be as great as those in connection with some other part of the boiler, a comparison of results compiled some time ago by the inspectors of a boiler-insurance company showed that a much greater proportion of defects of this kind were actually dangerous. For example, out of approximately 40,000 defects due to deposit of sediment, 20,000 were of incrustation and scale, and 4000 were of defective blowoffs, and practically the same number, 1200 of each kind, were listed as "dangerous." This same report shows that there were more than twice as many blowoffs in a dangerous condition as safety valves.

The boiler blowoff is used for two purposes—that of emptying the boiler for washing out, inspection or repairs, and for blowing out a small amount of water at intervals for the removal of impurities which collect and for preventing the boiler water from becoming too concentrated.

When emptying, the pressure should not exceed three or four pounds and the brickwork should be allowed to cool somewhat before blowing down, so that the boiler will not reabsorb heat after it is empty; otherwise any mud or soft scale present will be likely to bake on the shell and be difficult to remove.

The impurities which should be blown out at intervals vary in character according to the quality of the feed water and its service. In some cases considerable fine sand or mud may be held in suspension, also vegetable or organic matter in various forms, part of which will settle when the water is at rest and the remainder will float in the form of a scum, especially when mixed with oil from returned condensation that has not been properly purified. Impurities of the latter form can be removed only by a surface blowoff or skimmer. Feed water frequently contains various salts of lime and magnesia as well as other mineral substances in solution. Some of these will be precipitated by heat before the temperature of evaporation is reached, and others will remain in solution until the water has passed the point of saturation, due to evaporation, after which they also will be precipitated as a hard coating upon the boiler plates.

Substances that are thrown down before the boiling point is reached may be removed before admitting to the boiler by means of purifiers or certain forms of feed-water heaters; organic matter may be disposed of to a considerable extent by filtration. Mineral substances, which are precipitated only from a solution that has passed the point of saturation, must be cared for by frequent blowing off and the admission of fresh water to prevent sufficient concentration to bring about this result.

When outside purification is not carried on, then the soft mud or sludge that is precipitated by heat must be disposed of before it has a chance to harden, and may be blown out with the water that is discharged to prevent concentration. Hence, the dangers resulting from deposit, incrustation and scale, internal corrosion and burned plates can often be prevented, or at least minimized, by an intelligent use of the blowoff.

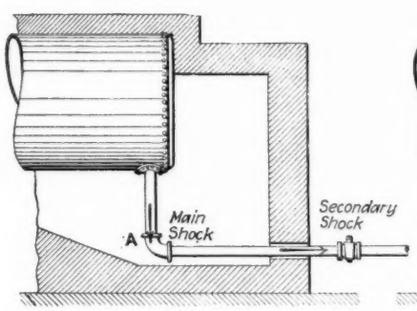


FIG. 1. SHOCK EXERTED ON ELBOW

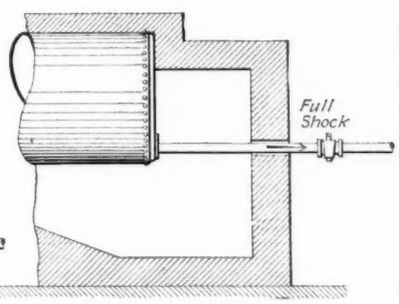


FIG. 2. SHOCK EXERTED ON VALVE OR COCK

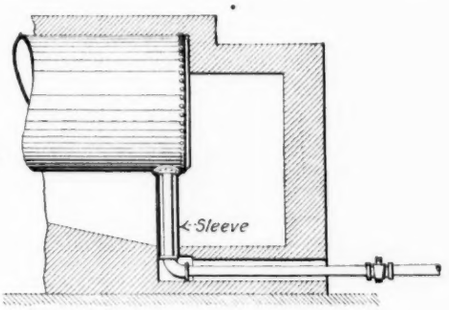


FIG. 3. FITTING PROTECTED FROM THE FIRE

A 100-hp. boiler will evaporate approximately 30 × 100 = 3000 lb. of water per hour, or 300 × 8 × 300 = 7,200,000 lb. per year, which is equal to about 900,000 gal. If each gallon of feed water contains 30 grains of dissolved mineral matter, which is a moderate amount, the total deposit of solid matter, provided the blowoff is not opened, will amount to 900,000 × 30 ÷ 7000 = 4000 lb., very nearly, or 2 tons.

Of course a boiler could not hold this amount without being practically destroyed by overheating, but boilers have been frequently inspected containing hundreds of pounds of deposit that had accumulated by neglect.

Every boiler should be blown down an inch or so at least once a day, and twice or three times when the water is bad and the boiler is operating at full capacity. The objection is sometimes raised that this causes too great a loss of heat and is, therefore, wasteful, but experience seems to prove that this practice is more than compensated for by the reduced cost of cleaning and also by the higher efficiency obtained, due to the more

rapid transmission of heat through plates that are kept comparatively free of sediment and scale. Boilers should be blown down only after they have stood quietly for an hour or so in order that the sediment may have had an opportunity to settle. The best time for doing this may be in the morning, before starting up the fires, or just before 1 o'clock, after the boilers have been standing idle during the noon hour, or at night, some time after the plant has been shut down, the most convenient time varying somewhat under different conditions.

In any case the blowoff should always be opened before the fire has been touched in any way, for the circulation of the water in the boiler will be established to some extent as soon as the fires are brightened. The effect of this will be to pick up a certain amount of the sediment and whirl it about, so the proportion blown out will be much less. When a blowoff pipe is flushed, it is not enough to open the valve a little way. It should be opened wide, if only for a few seconds, because if this is not done the full boiler pressure will not be realized and the pipe may not be thoroughly cleared. The quantity of water blown out, when flushing the pipe, is not of so much importance as that the full area be uncovered so that a solid column of water may seep through and carry away any deposit that may have accumulated. This process, it should be understood, is independent to some extent of that of blowing down the boilers, although they are usually combined.

Special attention is called to the proper method of opening and closing the blowoff valve. This should never be done suddenly, and for this reason a valve is better than a cock, because the former takes at least several seconds to open or close, but a cock may be quickly thrown from one position to another. It is not at all uncommon to see a fireman open a blowoff cock with a yank and close it with another. This practice is dangerous, and no valve about a steam system should ever be opened or closed suddenly, except perhaps in an unusual emergency, because sudden strains on a boiler or piping are much more destructive than those that come gradually. The enormous blow that may be struck with a solid slug of water, when its motion is suddenly stopped, can hardly be realized, especially when it is hidden from view; and a blowoff pipe discharging at a high velocity is as harmless in appearance as a heavily charged electric wire. However, both are capable of great damage if improperly managed.

It may be shown either mathematically or experimentally that stopping the flow of water instantly will increase the pressure, momentarily, about twenty times. Hence, when blowing down under 80 lb. pressure, an instant closing of the cock would raise the pressure to approximately $20 \times 80 = 1600$ lb. Of course, in practice, a valve or cock cannot be closed instantly, and the friction of the pipe also has some effect, but the foregoing gives an idea of the possible damage under ordinary working conditions.

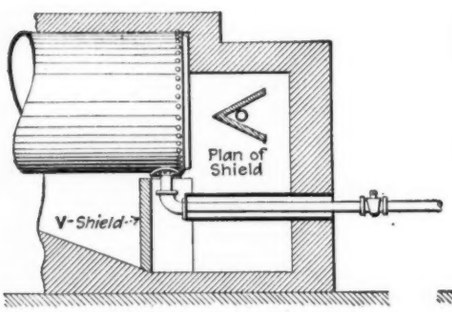


FIG. 4. ANOTHER METHOD OF PROTECTING BLOWOFF PIPE

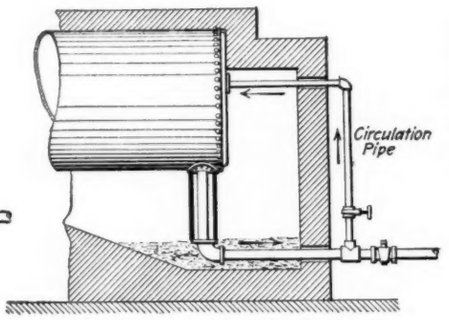


FIG. 5. ARRANGEMENT OF CIRCULATING PIPE

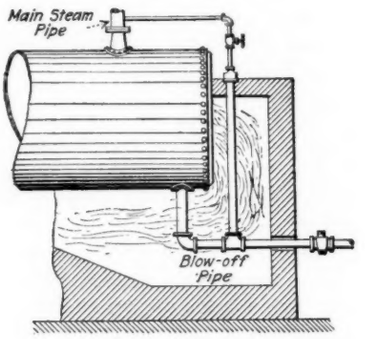


FIG. 6. BLOWOFF PIPE WITH STEAM CONNECTION

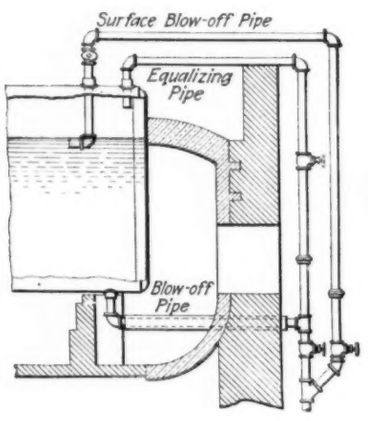


FIG. 7. BLOWOFF PIPE WITH STEAM CONNECTION

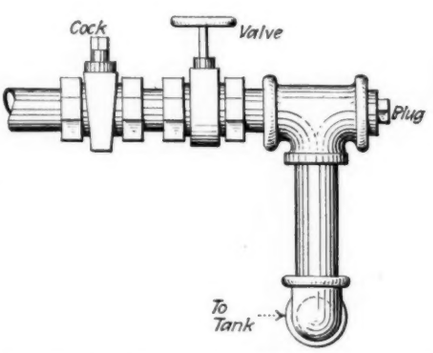


FIG. 8. PLUGGED TEE, USEFUL FOR DETECTING AND REMOVING SCALE

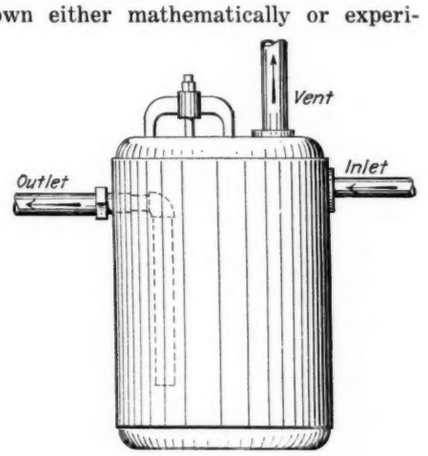


FIG. 9. BLOWOFF CONNECTION TO BLOWOFF TANK

It has been shown by computation that for a 3-in. blowoff pipe 5 ft. long, discharging under 80 lb. pressure, an instantaneous closing of the cock would cause a blow equal to over 2300 ft.-lb., or a force sufficient to raise a weight of one ton one foot in height. Of course, under actual conditions, there will be a certain amount of steam mixed with the water, which, with the friction of the pipe, will reduce the force of the blow somewhat. Neither can a fireman close the valve instantly, so the full force of the shock computed would not be realized. If this were not so, fatal accidents would be much more common than at present.

Blows of this kind are received by the pipe and fittings, which frequently rupture under the impact. A common point of fracture is at *A*, Fig. 1, where nearly the full force is taken by the elbow and a portion is passed on to the valve or cock. In Fig. 2 the full force of the shock is received by the latter. Sometimes threads are stripped instead of the fitting giving way, when the joint has not been properly made. As the force of the blow depends to a considerable extent upon the weight of the slug of water contained in the pipe, it is evident that the pipe should not be larger than necessary to carry off the sediment and scale without danger of clogging the pipe.

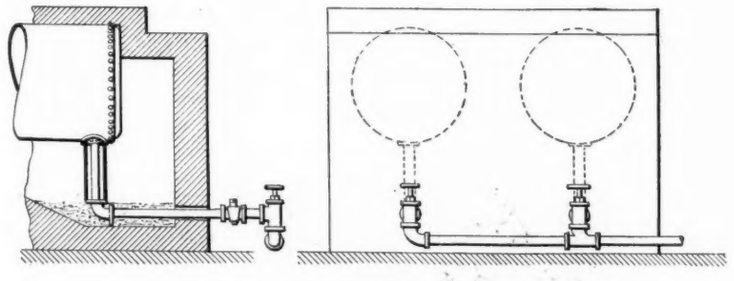


FIG. 10. TYPICAL ARRANGEMENT OF BLOWOFF PIPING CONNECTIONS

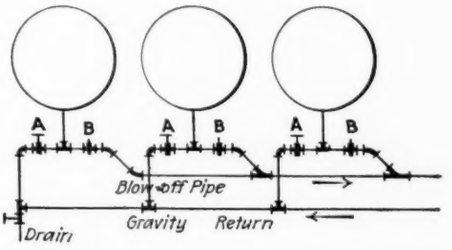


FIG. 11. BLOWOFF PIPING ARRANGED FOR LOW-PRESSURE RETURN

Insurance companies recommend 1½ to 2½ in. as the limiting diameters for all the ordinary conditions. The A. S. M. E. Boiler Code recommends a minimum size of pipe and fittings of 1 in. and a maximum size of 2½ in. Globe valves are not to be used in such connections. The length of pipe also adds to the weight of water contained, and should be no greater than necessary to give the proper flexibility and to make it accessible for operation and repairs.

The method of making the blowoff connections will vary somewhat with local conditions, although there are certain general precautions to be observed. Two ways of bringing the pipe outside the setting, in case of a return-tubular boiler, are shown in Figs. 1 and 2. The latter has the advantage of having no fittings exposed to the fire within the setting, but it does not fully drain the boiler and therefore allows mud and sludge to remain on the bottom of the shell, where it is likely to bake into a hard scale and so produce burning or bagging of the plates. Fig. 1 gives much better drainage, and the elbow may be protected by carrying the horizontal portion below the paving, as shown in Fig. 3. Practically the same result is sometimes obtained by running the horizontal portion just above the paving and allowing it to become covered with soot and ashes.

In any case the blowoff pipe should be protected by a sleeve of cast-iron pipe of sufficient size to provide an air space of at least one-half inch around it. Even though the pipe is carried below the paving, as in Fig. 3, it is necessary to make some arrangement for freely admitting air within the sleeve surrounding the vertical section, which may be done by making a brick or concrete channel around the horizontal pipe, which will connect with the vertical sleeve, as indicated. Sometimes a V-shaped brick pier is built on the fire side of the pipe, thus protecting it from the direct action of the burning gases, as shown in Fig. 4.

A matter of great importance in the installation of blowoff piping is proper threading at the joints, and many serious accidents have been due to neglect of this precaution. Care should be given to this work, the threads should be full and perfect and have such a taper that the pipe will enter the fitting or valve to a sufficient depth to make a strong and durable joint.

Unless the pipe is carefully protected and blown out at frequent intervals, there is danger of its becoming overheated and burning out. When sediment accumulates it, of course, diminishes the amount of water in the pipe or practically excludes it in some cases, so that there is no way of carrying away the heat and the pipe becomes white hot and softens, thus making rupture an easy matter. This danger is frequently guarded against by the piping arrangement shown in Fig. 5, which sets up sufficient circulation to prevent the accumulation of sediment or overheating of the pipe.

A pipe may burn out even though there is no sediment present, owing to the formation of steam which forces the water back into the boiler and leaves the pipe exposed to the full heat of the fire without any means of cooling it. This condition may be prevented by making a steam connection with the blowoff pipe, either inside or outside the setting, as shown in Figs. 6 and 7. This carries off the steam as fast as it is formed and thus prevents the water from being forced out of the pipe. When there is much sediment, the plan shown in Fig. 5 seems preferable, because it not only guards agains the plugging up of the pipe, but also prevents boiling and the formation of steam; the arrangement shown in Fig. 6 only prevents one undesirable condition.

The arrangement shown in Fig. 7 also combines a surface blowoff for removing any scum that may form on the water owing to the presence of organic matter. The collecting nozzle has considerable width so as to extend partly across the boiler and is often carried on floats, with a flexible connection so as to always be in a position to catch the scum whatever the elevation of the water level.

No bolted flanges should be located where exposed to fire, although a certain number will be found convenient

outside the setting for use when disconnecting for repairs. The reinforcement, where the blowoff pipe is connected with the boiler, should be drilled and tapped as a unit with the shell, instead of being punched to a larger size as is sometimes done. In this way a threaded joint of sufficient length for proper strength may be obtained.

Whenever the pipe is placed as in Fig. 4, the sleeve surrounding the horizontal portion should be brought out through the brickwork, in order to provide a good inlet for the circulation of air. A typical arrangement for the piping connections outside the setting is shown in Fig. 10. A cock and valve are used in this case, with the former next to the boiler. When used, the cock should be opened first and closed last, when no water is passing through it, thus greatly reducing the wear, as there is no scoring of edges or ground surfaces. The same method of operation applies when two blowoff valves are used instead of a valve and cock. In some cases the cock is left open at all times, thus being kept in condition for cases of emergency only.

By using a plugged tee instead of an elbow, as in Fig. 8, it is possible to remove the plug and detect leaks in either cock or valve. It is also possible to insert a rod for the removal of scale in case the pipe should become plugged, it being understood, of course, that the pressure on the boiler has been brought to zero before opening the valves. The connection from each boiler is best brought into the main pipe on an angle by means of a Y-fitting in order to reduce the chances of clogging.

A common arrangement for a low-pressure heating system, where the condensation is returned by gravity through the blowoff pipes, is shown in Fig. 11, in which case any unit may be blown off independently of the others and without reference to the return, by closing valve *A* and opening cock *B*.

When practicable, it is better to let each boiler have a separate discharge, either into a trench in the open air or into the sewer. In most localities the latter method is prohibited by ordinance because it is more or less injurious to the sewer. In such cases an intermediate blowoff tank is necessary, to which all the boilers are connected by a header or main common to them all. A typical blowoff tank is shown in Fig. 9 and should be so constructed as to permit the steam and water to separate, the former escaping to the atmosphere through a vent, and the water into the sewer under the combined influence of gravity and such pressure as may exist in the tank. The shell is commonly made of ⅜-in. iron or steel, with ½-in. stock for the heads. With a 2-in. inlet the outlet should be at least 3 in. and with a 2½-in inlet, a 4-in. outlet. The vent is commonly made about an average of the inlet and outlet, although it is frequently given the same size as the latter.

A boiler should never be blown off into a tank that is already full of water or nearly so, because the violent discharge of more water is certain to produce a considerable increase in pressure, especially before a flow has been established through the outlet. Under such conditions the pressure in the tank may approach that in the boiler, and this fact, taken in connection with the known law that a sudden load or pressure has twice the effect of an equal load when applied gradually, goes to show how serious may be the consequences of blowing off suddenly into a tank that is already full.

Water Rheostat for Testing 2400-Volt Three-Phase Generators

By C. E. Inman

A novel rheostat was used by the writer some time ago, when it became necessary to test three-phase 60-cycle 2400-volt generators installed in a hydro-electric

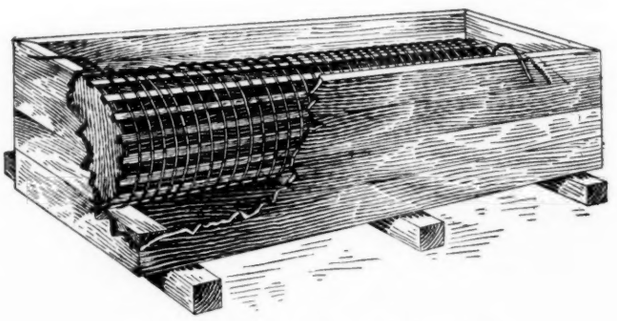


FIG. 1. COIL OF IRON WIRE IN TUB

power house before enough load was obtainable to use the current capacity of one machine. There were three units—one generator of 850 and two of 1250 kv.-a. each.

Three tubs were obtained, formerly used in a dye-house, which were 21 ft. long, 26 in. wide and 26 in. deep. In each tub was placed an open spool, or reel, 18 in. in diameter, on which was wound 2100 ft. of No. 8 B. & S. gage galvanized steel wire, as in Fig. 1, care being taken to keep the wires evenly separated. The coils in the three tubs were connected in star for the

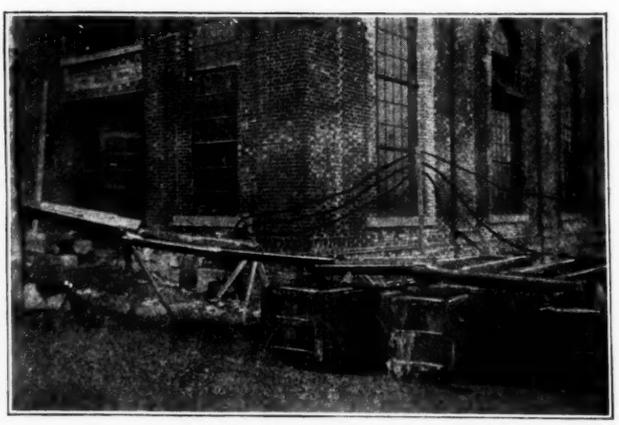


FIG. 2. GENERAL ARRANGEMENT OF RHEOSTAT LOCATED OUTSIDE OF POWER PLANT

850-kv.-a. generator and in delta for each of the 1250-kv.-a. units.

Water for cooling purposes was obtained from the forebay, the tubs being allowed to run over enough to keep the temperature down on the coils. A view of the general arrangement is shown in Fig. 2. Each generator was allowed to run as long as necessary, and the rheostat gave satisfactory results.

Oil can be removed from feed water by filtration, the common practice being to place the filter between the steam pump and the boiler. There is really no excuse for allowing oil to enter a boiler in such quantities as to be a menace to its safety or to cause damage as will necessitate expensive repairs.

Reagan Automatic Stoker

That attention is being given to boiler-room economy is evidenced by the numerous designs of mechanical stokers that have been developed during the last few years and to improvements of existing stokers. The more simple a stoker can be made and at the same time operate efficiently, the better. The less room it requires in a boiler house the more popular it will be, the more automatically it will operate, the higher its standing among engineers and the higher rating at which a boiler can be made to operate with it, the more efficient it will be.

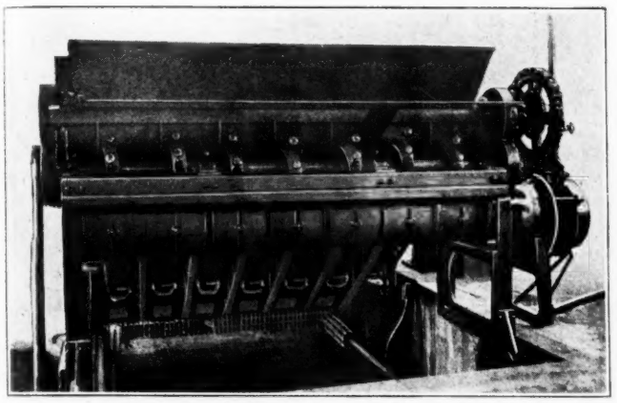


FIG. 1. FRONT VIEW OF THE NEW REAGAN AUTOMATIC STOKER

When the Reagan automatic stoker was in the process of development, the foregoing features, together with others, were kept in mind, with the result that a new stoker has been designed, that its makers, the Reagan Grate Bar Co., Pottstown, Penn., claim is not surpassed by any other.

The new stoker is a self-contained unit, carrying its own forced-draft apparatus. It has an adjustable feed of from 0 to 60 lb. of fuel per square foot of stoker surface per hour, is equipped with a mechanical ash unloader, water-cooled water beam under the rest grate and water-cooled bridge-wall and ash-pusher.

The stoker, Fig. 1, extends 33 in. from the front of the boiler setting proper, and is so designed that no fuel siftings can fall into the space under the grate. All parts are interchangeable. The stoker can be made in any size up to that sufficient to operate with any boiler horsepower. Burning 45 lb. of coal per square foot of stoker area per hour with 7/10 in. of forced draft in the air ducts and 2/10 over the fire requires but ¼ hp. to operate the stoker. A shearing pin that extends through a suitable hole in the sprocket wheel and into a flange secured to the driving shaft prevents damage to the stoker due to foreign material in the coal or any other cause. The pin can be removed with the fingers, and the sprocket wheel then runs loose on the shaft.

Coal is fed into the hopper, from which it is pushed out on the coking block *A*, Fig. 4, by a reciprocating semicircular feeding block *B*, which receives motion from a shaft that extends across the stoker below the hopper and which is driven by a sprocket wheel on one end that is chain-driven from either a motor or engine. The outer end of the feed shaft is fitted with a trigger arm *C*, Fig. 3, forked at the bottom and in which fork the ratchet connecting-rod *D* runs and is supported by a pin. Regulation of the pusher member is obtained by the adjustable head *E*, which carries a lever *F*, Fig. 2.

By lifting the ball end of the lever, the teeth on the other end are disengaged from the teeth on the upper side of the connecting-rod *D*, Fig. 3, thus permitting the lost play between the head *E* and the stop on the end of the rod *D* to be made more or less. With the head *E* close up to the crank, the pusher will be moved full stroke; any additional lost motion between the head *E* and the crank will reduce the stroke of the pusher, thus admitting of an adjustment of from no feed to full capacity.

Fuel is first fed into coking plates *A*, Fig. 4 and then travels to the bottom of the stoker inch by inch, owing to the movement of the step-plate sections, the number of which depends on the size of the stoker.

Not only can the initial feeding of the coal be regulated by the adjustable feeding device, already described, but a similar eccentric arrangement actuates each step-plate section, thus permitting their individual movement to be regulated independently of one another and separately from the feeder. By means of these refinements the stoker can be made to feed any amount up to 60 lb. of coal for every square foot of stoker area.

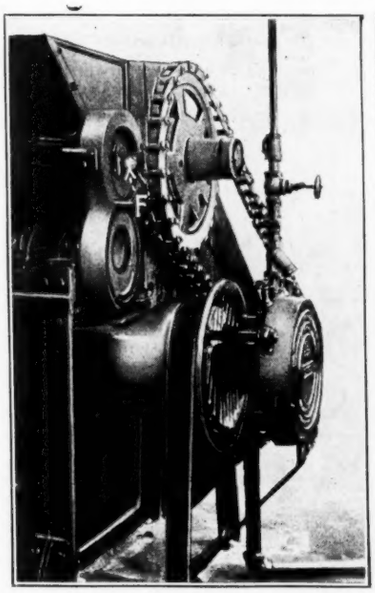


FIG. 2. SHOWING GEAR DRIVE OF ECCENTRIC SHAFT

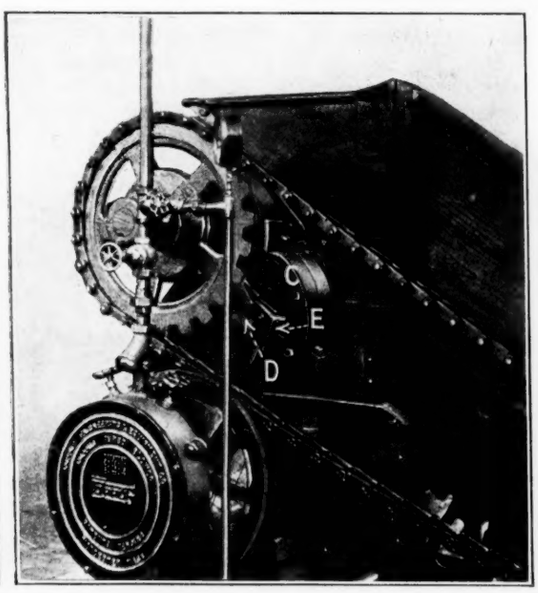


FIG. 3. SHOWING BLOWER, SPROCKET DRIVE AND FEEDER BLOCK DRIVE

Each step-plate section is supported on the under side by small trolley wheels that travel on a trolley track. Air from the self-contained blower is delivered through air ducts to the air openings in the step plates. These plates are made in sections that are easily and quickly removed. They overlap, thus preventing siftings of fuel in the air duct. The faces of the step plates are made with ½-in. diameter holes, each about 1 in. deep.

These holes fill with ashes and protect the metal against burning. One-fourth inch air holes are distributed between the ash holes, through which air and steam are admitted to the fuel bed.

Air is supplied by a self-contained turbine-driven blower.

The air, going through a main windbox *H*, Fig. 4, and passing through the hollow mouthpiece *I*, enters the air ducts that extend the length of the step-plate section and then escapes through the airholes in the step plates. Not only do the airholes supply the necessary air for combustion, but they also feed steam coming either from the stoker engine, fan turbine or from an auxiliary source. The steam is discharged into the air ducts through perforated pipes and escapes through airholes to the under side of the fuel, forming a water gas. This steam also escapes through openings at the bottom of the grate and acts to rot such clinkers as may form. The steam, together with the oscillating movement of the step-plate sections, prevents the formation of clinkers.

No ashes can be deposited in the space below the stoker, as any slight siftings that might occur go into the air ducts. This slight accumulation is blown out when a sliding gate is pulled out at the bottom of the air ducts.

From the water-cooled rest grate *G*, the ashes drop into an ashpit from which they are removed by a mechanically operated ash pusher head *K*, Fig. 4. This ash pusher runs on trolley wheels and tracks and is water-cooled. It is actuated by means of follow rods, Fig. 4, one on each side, and which are connected through the bell crank *M* and sliding rod *N*. It is capable of handling 1500 lb. of ashes at one movement.

When it is desired to remove a portion of the ash accumulation, a pin *O* is inserted in the rods *P* and *N*, the former fitting into the hollow rod *N*. A downward movement of the rod drags the head *K* to the end of its track and pushes a slug of ashes out into the ashpit. One revolution of the crank *R* removes the pusher head out and back from and to its position in the bridge-wall, as shown in the illustration, where, when it is not in use, it is fully protected from the furnace heat.

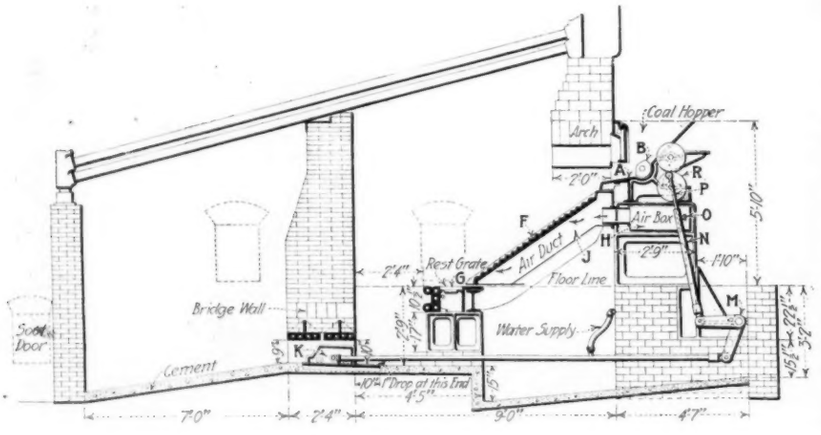


FIG. 4. SECTIONAL ELEVATION THROUGH THE REAGAN STOKER

Not only is the rest gate and ash-pusher head water-cooled, but that part of the bridge-wall immediately over the ash-pusher head *K* is also cooled by circulating water.

In Fig. 5 is shown a plant of the water-cooled system. Water enters the bridge-wall beams, as shown, through the pipe *A* and after making eight passages through the bridge-wall is piped to the water beam of the rest gate, where it makes five passages and then flows to the inlet side of the hollow ash-pusher rods and passing through the pusher head discharges into a hot-well, from which it is pumped for boiler use.

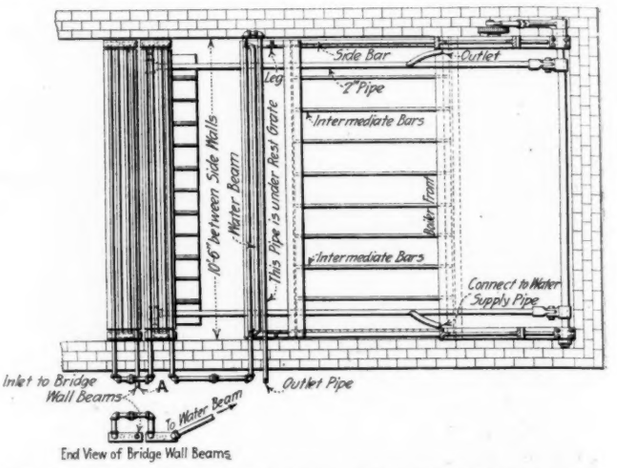


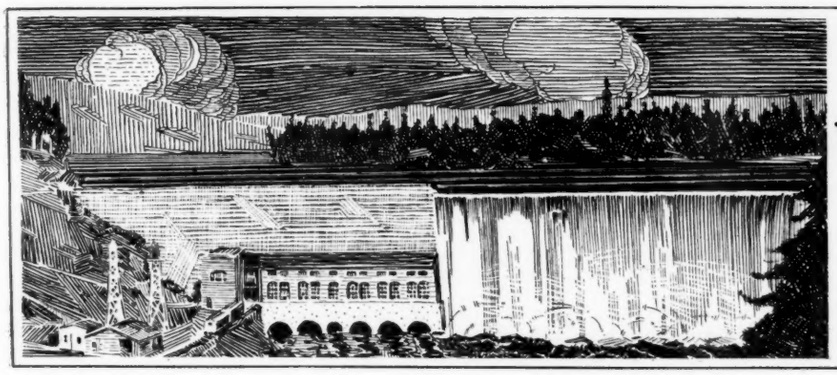
FIG. 5. SHOWING WATER CIRCULATION THROUGH BRIDGE-WALL. WATER BEAM AT REST GATE AND ASH-ROCKER HEAD

In an address regarding England's economic problems C. A. McCurdy, parliamentary secretary to the British food controller, said: "Every year we use in England 80,000,000 tons of coal for motive power to drive machinery to help the workers to produce the things we want. Man for man we use in industry half as much coal again as they do in America, but we do it so badly, so wastefully, that one ton of coal used to assist the worker in the United States gives him 50 per cent. more help, 50 per cent. more motive power, than 1½ tons used to assist the British worker."

In the early day of the development of electrical machinery it was not uncommon to use sheets of pure mica for insulation that were 10 or 12 in. square. The available large sheets of pure mica have been so reduced that a sheet 10 in. square is looked upon as a curiosity, yet the use of mica has increased many hundred tons.

A young chemist who started out 30 years ago to manufacture coach varnish became the head of the pioneer firm devoted exclusively to the production of insulation varnish for electrical machinery.

With the high cost of bituminous coal, power-plant operators are investigating the possibilities of fuel oil. It is necessary, of course, to make provision for storing the oil, and a common size of storage tank that is used holds about 10,000 gal. One 8 ft. in diameter and 30 ft. long will have this capacity. Such tanks are provided with a manhole, a filling connection, a suction connection, vent opening, and a connection for steam-heating coils. Fuel-oil tanks are generally placed below the level of the boiler and oil pump.



POP'S WATER-POWER COURSE

By

John S. Carpenter

"THIS time we tackles the subject of regulation," began Pop. "By that we means regulatin' the water quantity supplied to the wheel or turbine so the speed can be kept as constant as possible. Seein' as how we has jes' gradyated from the study of Pelton wheels, we will take them up first, 'cause in some respects the regulation of typical Pelton-wheel plants offers some of the prize puzzlers."

"I suppose, Pop, that the proposition isn't much different from the problem of governing a steam turbine. A set of flyballs, a little throttle valve, a couple of levers and rods—and there you are!" Jimmy affected the confident, easy air that cub salesmen spring on Pop—to their sorrow.

"Well, young feller, you jes' ain't all there! See?"

"No, I don't see; tell us all about it," said Jimmy.

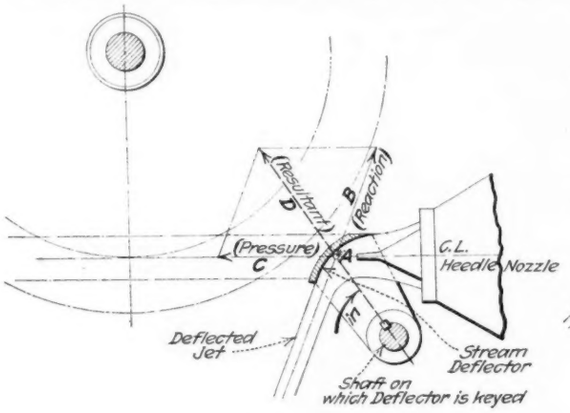


FIG. 1. BALANCED STREAM DEFLECTOR

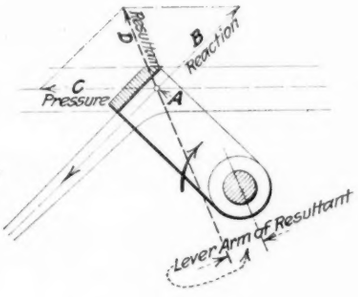


FIG. 2. UNBALANCED STREAM DEFLECTOR

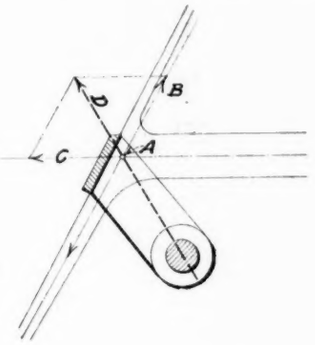


FIG. 3. "FAKED" STREAM DEFLECTOR

"First, steam an' water is two different critters. One is like a pet cat, t'other's a derned circus mule. You take, fer instance, a cubic foot of steam at 200 lb. gage an' it don't weigh even a half a pound, while with water, for all practical purposes, it weighs about 62.35 lb. per cubic foot whether it's under one-foot head or two thousand! It's the mass in water that counts. You know dern well you can shut down a pipe havin' steam flowin' in it at the rate of 15,000 ft. a minute purty quick, even if it's toler'ble long; but let me ketch you tryin' it on any of the water lines 'round this here plant! You know it's gotta be done easy or ten chances to one you'll bust a few fittin's.

"Now we'll take a little case. We'll assume, to start the scrap, that we have a turbine plant in which the turbine is fed by a pipe line, the length of the same bein' about three times the head—an average case. We is runnin' purty near full load, an' now comes a slump—say 50 per cent. load off. The first thing that happens is that the speed rises. If we had no governor on the unit, it would theoretically rise 100 per cent.; actually, it rises much less, 'cause the efficiency drops off a lot when the wheel is overspeeded, on account of shock on the runner vanes. But we have a governor—say it's jes' a set of flyballs and a throttle valve. The speed havin' increased, the governor moves the throttle valve toward the closed position. Remember the velocity in the pipe line is now only about half of what it was before 'cause we is usin' only about half the previous amount of water. Now the other half of the velocity has to be destroyed in some way. It can't escape, so it commits suicide by stretchin' the pipe an' increasin' the pressure head. Now, as soon as the pressure is increased it takes less water than before to carry the load an' keep up the speed. The speed rises again. The governor shuts the throttle valve still more. By this time the pressure wave has reached the bottom of the pipe line an' is now bein' reflected up to the forebay, so the pressure head goes down now and the speed will drop, causin' the governor to open the valve again. An' so this seesawin' will continue until the load shifts from one generator to the others. Sich a condition of affairs is technically called 'huntin'."

"In other words, with a governor like that you'd be always between the devil and the deep sea," Jimmy summarized. "But now how do they turn the trick?"

"It's done with a dashpot an' a relay or compensatin' device, all of which will be dooly taken up in our next talk. The main thing we has to consider now is how the Pelton wheel is governed. In order to understand anything about the proppysition at all, I had to give you a little idee how it's pulled off.

"Take a look at Fig. 1. Here you sees what is called a stream deflector. It does jes' what it says—deflects

the stream. Now they is two kinds of stream deflectors. One is made very cheap by bendin' a piece of flat bar iron into a U-shape. If you feels kinda particular you might sharpen up the edge that cuts into the stream. Now that kind is dern hard to operate, 'cause it ain't balanced, a good deal like comparin' the old-style slide valve to the purty balanced piston-valve gears of today. An' t'other kind—yes, you guessed it, son—t'other kind

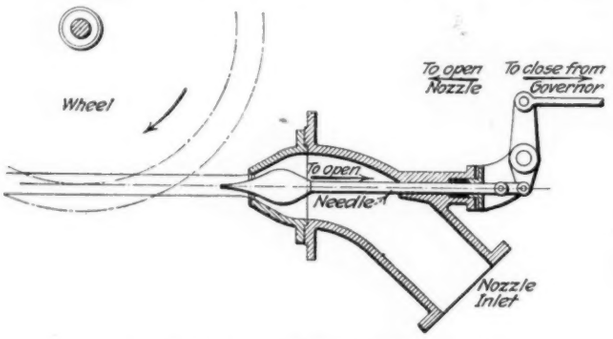


FIG. 4. PLAN OF DIRECT NEEDLE CONTROL

of stream deflector is balanced and easy to operate."

"How can a fellow tell if the thing is balanced or not? And how can you figure the pressure of the jet on the deflector?"

"To tell whether a stream deflector is balanced or not, you don't have to go an' figger stream pressures. It can be done very simple. Jes' take, an' turn to, an' go to work an' draw a line through the center of the deflected jet and one through the middle of the stream. From the point *A* where they intersects on the center of the stream, you measure off, say, one inch an' draw in that line kinda heavy. Now do the same with the other center line you drawed through the deflected jet. Then you has two lines of force, *B* an' *C*. We completes the parryllelogram as shown, an' we gits the resultant of them two forces *B* an' *C*. I don't care what the resultant is, whether it represents ten pounds or a thousand—at least not for this purpose."

"Yes, but what do those lines represent, Pop, and why are they equal?"

"Them lines, son, is the stream pressures drawn to scale. They is equal by Newton's law, which says every action has an equal an' oppysite reaction. All I wants to know is, when I lengthen out that resultant *D*, is it gonna go through the center of the deflector shaft or ain't it? If it does, then the critter is balanced. If it don't, then you'll find it has a tendency to turn either one way or t'other an' your governor has to keep it in that position. When the resultant goes through the center of the deflector shaft, then the governor only has to take care of the friction in the bearin's. This kind of deflector ain't balanced in *all* positions, but when it is cuttin' into the jet about all the way, that's the only time the pressures amount to much, and then it's so near balanced they ain't no fun arguin' over it. Doin' the same trick with the critter made outa a piece o' flat iron, shown in Fig. 2, you sees the resultant goes off to one side of the shaft center. You can make the resultant go through the center of the shaft by bendin' the part that cuts in, as in Fig. 3, but then some of the water actually will shoot out of the top of the dingus an' it'll be unbalanced in actual practice.

"It's only fair to say," Pop continued, "that this balanced stream deflector is patented, an' the patents is owned by the Pelton Waterwheel Co."

"If I get your sketch in Fig. 4 right, it's a needle nozzle directly controlled by the governor. Darn if it isn't simple!" declared Jimmy, relighting his cigar.

"It is, if the pipe-line conditions let you use sich a riggin'. S'posin' they is a long pipe line, say five thousand feet long, an' the water in it has a purty good velocity—fer instance, call it six feet at full load—then you couldn't use an arrangement like that nohow! If you shet the water off quick you'd prob'ly soon be writin' out a requisition fer a new pipe line if you stood in well with the boss, or else be huntin' an' outa-town job, if the boss liked you middlin' to punk. We'll see later on how a heavy flywheel helps sich a plant."

"One great big advantage that I can see in the method of direct governing by the needle is that it saves the water which the stream deflector wastes," Jimmy observed with great dignity.

"Yes, that's so. The point here is that the stream deflector don't change the velocity of the water in the pipe line, and so don't create any jimjams in the regulation problem with pressure rises that could jes' as well be left out so far as good regulation is concerned. In sich doin's an ounce o' prevention is worth a hull ton o' cure. In the wild an' woolly West they has plants on some o' them rivers that has to be used fer irrygation. So on sich plants the water must be kept agoin', an' they has laws which says it can't be shet off. So you see in them cases you gotta use some kinda hickey which don't shet the water off, but deflects it off'n the wheel.

"An' now, about the regulatin' with the needle, or usin' another name, the water-economizin' nozzle. You really can use it on any plant where the law allows you to shet the water off, provided you opens the nozzle quick and closes it gradual. Openin' it quick, of course, makes the pressure go down, an' the flywheel capacity of the rotatin' parts has to carry the load fer a time over the slump, but it ain't as bad as when the pressure goes way up on account of changin' the velocity in the pipe line.

"Right here I wanta say a few things on the subject of the relief valve. The idee is that when you has a long pipe line an' the velocity must be changed quick

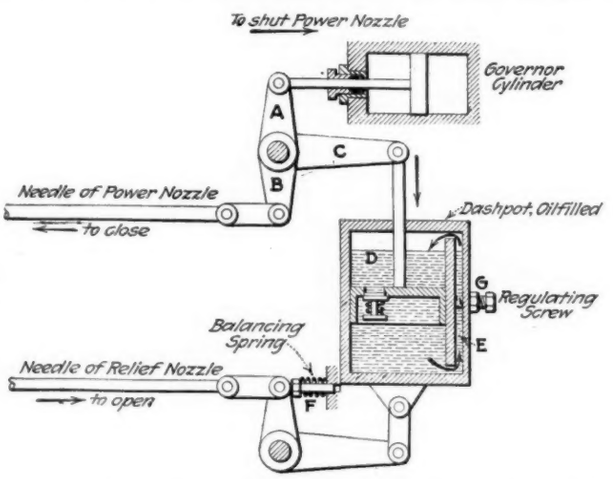


FIG. 5. SYNCHRONOUSLY OPERATED RELIEF VALVE

from fast to slow, a relief valve set on the lower end of the line will help matters a great deal. The great trouble is to git enough relief valves to handle the pressure increase. The valve used is most gen'ly boiler-type with a fair-sized lip on the valve so the pressure can vary a few pounds without makin' the valve pop all the time. The minute sich a valve opens, it's gonna stay open till the pressure gits three to five pounds below what it's set to blow at—on account of the extry area of the lip—

which it wouldn't do if the valve didn't have any lip to it."

"You mean, Pop, that if the valve didn't have a lip it would be chattering all the time as soon as the pressure got high enough to overcome the force of the spring and the friction in the valve parts."

"Uh-huh," mumbled Pop; "that's right. Many engineers has serious objections to the idee of a relief valve that gits its cue to git busy from the pressure rise alone. The valve might stick fer some reason or other and then the pipe line might go up in smoke. These gents demands somethin' that goes on the job as soon as the governor moves, that will open as much area to relief as the governor shuts down on the power nozzle. They calls these the synchronous relief. To put it plainer, let's say the governor starts to close the nozzle, due to a drop in load. In the first instant of time, we'll say the governor closes off two square inches of nozzle area. Now, in order to keep the pipe-line velocity the same, the relief nozzle must open up two square inches of area at the same time, an' so on. When you has a riggin' that will do that, you don't at least theoretically, git any pressure rise, 'cause you ain't stoppin' the flow in the pipe line. Now, to save water they is a dashpot usually provided that will close the relief nozzle very slowly so the velocity will be very gradually changed.

"Consider Fig. 5 careful-like, Jimmy. Let the force of the governor be applied at the lever *A*, the same movin' the levers *B* an' *C* as shown. We'll say the governor starts to close the nozzle used fer power. At the same time the end of the lever *B* moves to the left to shet off some area, and the lever *C* moves downward to open the relief nozzle. Now, you'll see that the valve *D* in the piston of the dashpot would only open if the piston moved upward, an' since in this case it moves down, it tries to force the oil in the dashpot through the narrer port *E* at the side. This takes so much force that the lever shoves the hull dashpot down without movin' the piston relative to the cylinder. For the time bein' it might jes' as well be a rigid connection between the two levers, as the governor works so fast the oil ain't got time to beat it around to the other side of the piston. The relief nozzle is now open and dischargin' as much water as the governor shet off on the power nozzle. You'll notice, son, a spring *F* behind the lever that controls the relief nozzle. This spring should be jes' strong enough to balance the thrust of the needle, the weight of the dashpot cylinder with its link and lever, plus a small amount extry for friction. So jes' as soon as the governor is done movin' the piston the spring slowly returns the dashpot cylinder upward, which closes the relief nozzle. The time of closing is regulated by the little setscrew *G* on the dashpot and the adjustin' nut on the spring *F*.

"When the call is for more juice, then the governor opens the power nozzle more; at the same time the dashpot piston moves up very fast because the valve *D* opens and lets the oil through from the upper to the lower side of the piston, the result bein' that the dashpot cylinder remains stationary and the relief-nozzle needle is not moved. So we fulfills the conditions of quick opening in response to the call fer more juice, and in the case of load off the power nozzle is quickly closed and the relief nozzle slowly shet down without injury to the pipe line. The next time we meet we'll study the oil-pressure governor."

The Electrical Study Course—Fundamental Principle of the Transformer

The advantages of transmitting power electrically at high voltage is shown by examples, and then the fundamental principle of the transformer is discussed.

THE transformer is a device for changing the voltage of alternating-current circuits. The advantages of making such changes are manifold, but their particular usefulness is in their application to electrical transmission. By means of their use it is possible to generate the electricity at a moderate voltage, then increase the voltage, and transmit it at high pressure to the point of demand, where the voltage can again be reduced to a value that is safe to handle. The advantage of transmitting electrical energy at a high voltage will be made apparent from the following:

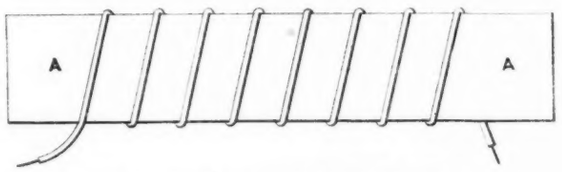


FIG. 1. COIL OF WIRE ON IRON CORE

Assume that we have a line of No. 4 wire one mile long, over which we wish to transmit 500 kilowatts. If this power is transmitted at 50,000 volts, the current would be $\frac{W}{E} = \frac{500 \times 1000}{50{,}000} = 10$ amperes. The loss in the line would be $I^2 R$, where I is the current flowing and R the line resistance. The resistance of 2 miles of No. 4 wire is 2.572 ohms. Hence $I^2 R = (10)^2 \times 2.572 = 257$ watts. If, on the other hand, we were to transmit at 10,000 volts, we would have $\frac{W}{E} = \frac{500 \times 1000}{10{,}000} = 50$ amperes, from which $I^2 R = (50)^2 \times 2.572 = 6430$ watts. At 1000 volts, $\frac{W}{E} = \frac{500 \times 1000}{1000} = 500$ amperes, giving $I^2 R = (500)^2 \times 2.572 = 643{,}000$ watts; that is, we would lose more than the total amount of energy we are trying to transmit, which is impossible.

Another way to look at the situation is, that for a certain allowable loss in the line we can use a much smaller wire at a high voltage than we can at a low one, since the current varies inversely with the voltage. Thus, in the foregoing examples, when $E = 50{,}000$ volts, $I = 10$ amperes; when $E = 10{,}000$ volts, $I = 50$ amperes; and when $E = 1000$ volts, $I = 500$ amperes. If we wished to limit the line loss to 5 per cent., it would be $0.05 \times 500 \times 1000 = 25{,}000$ watts. At 10 amperes we have $(10)^2 \times R = 25{,}000$ watts, or $R = \frac{25{,}000}{100} =$ 250 ohms, making the resistance per 1000 ft. equal to

$\frac{250}{5.28 \times 2} = 23.67$ ohms. From the wire table we find that a No. 24 wire would serve. At 50 amperes we have $(50)^2 \times R = 25{,}000$ watts, or $R = \frac{25{,}000}{2500} = 10$ ohms, making the resistance per thousand feet equal to $\frac{10}{5.28 \times 2} = 0.947$ ohm, requiring a No. 10 wire. At

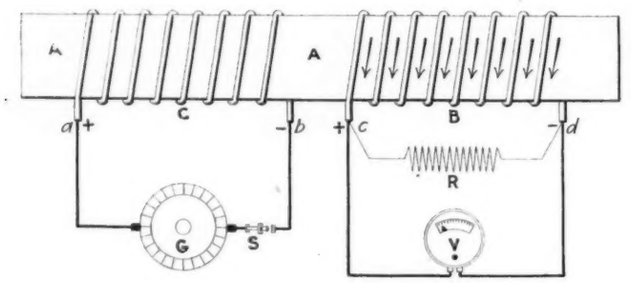


FIG. 2. TWO COILS ON IRON CORE.

500 amperes we have $(500)^2 \times R = 25{,}000$ watts, or $R = \frac{25{,}000}{25{,}000} = 1$ ohm, which causes the resistance per thousand feet to be $\frac{1}{5.28 \times 2} = 0.0947$ ohm, corresponding to a No. 0 wire.

The conclusion to be reached from the foregoing is, that by transmitting at a high voltage we can either save on the loss in the line for a given size wire, or we can use a smaller wire, and therefore save in construction cost, for a given allowable line loss. The fact that we can readily "step up" and "step down" alternating voltages by means of transformers gives alternating-current practice its greatest advantage over direct current, for with direct current we cannot use transformers. The only method of raising or lowering direct voltages is to use motor-generator sets, and the voltage on these is limited by the fact that commutators must be used. Even if that difficulty did not exist, we would still be confronted with the fact that the motor-generator set requires an attendant, whereas the transformer does not. That is, in a transformer we can convert from one voltage to another without the use of any moving parts whatsoever and, moreover, without any electrical connection between the two voltages. How this is possible is brought out in what follows.

If current is passed through a coil such as that shown in Fig. 1, the iron core *A* becomes a magnet. Suppose such a coil to be wound upon the same core with another coil *B*, as in Fig. 2. At the moment the switch *S* is closed, a current flows through coil *C*, causing *A* to become a magnet. The magnetic field thus introduced into *B* generates a voltage in it that can be read on voltmeter *V*. This voltage lasts only for the instant occupied to build up the field in *A;* as the field reaches its final value and stops increasing, the voltage at *V* drops to zero again. When the switch *S* is opened and the field in *A* collapses, a voltage is again momentarily generated in *B*. The reason for this can be explained by reference to Fig. 3, which shows a longitudinal section of the coils and core. The magnetic field may be represented by the broken lines. It will be seen that they form loops, as at *L*. When the field begins to build up, these loops, beginning at nothing, expand and in so doing cut across all the wires *W* and *X*. We know that when a magnetic flux cuts across a conductor a voltage is generated in the latter, hence the voltage registered by *V* in Fig. 2. Again, when the field is reduced to zero, as by the opening of switch *S*, the loops of the field in Fig. 3 contract, and consequently cut across the conductors *W* and *X*, as before, but in the opposite direction. Hence, the voltage that appears across the terminals of *B* when the current through *C* in Fig. 2 is broken. Since the lines of force, when contracting, cut the conductors in the opposite direction to that in which they cut them when expanding, it is to be expected that the voltage registered by *V* when the switch *S* is opened is opposite to that which it registers when the switch is closed, and such is the case. Moreover, it will be found that the direction of the voltage in *B* is opposite to that in *C* when the coils are wound in the same direction as they are in Fig. 2. Thus, when *a* is plus and *b* minus, we find that *c* is also plus and *d* minus. This can readily be understood by tracing out the directions of the magnetic fields. If *a* and *b* in Fig. 2 are plus and minus, respectively, as assumed, then the current in the conductors at *T*, Fig. 3, will be into the surface of the paper, and that of those at *U* will be out from the surface. Consequently, the lines of force around the former will be in a clockwise direction and those around the latter in a counterclockwise direction, as indicated by the arrows on the circles around the conductors. It will be noted that all these arrows inside of the coil point from right to left, causing the left-hand end of the core to be a north pole and the right-hand end a south pole. The direction of the line of force outside of the core will therefore be from left to right, as indicated by the arrows on the broken lines. When the field expands upon first being set up, these lines will move down along the core to *S* and will cut the conductors *W* and *X*

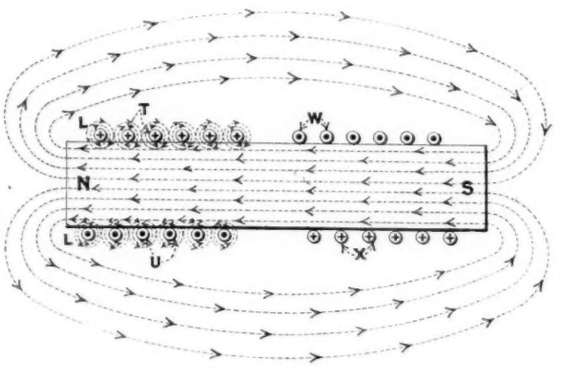


FIG. 3. SECTION THROUGH COILS AND CORE, FIG. 2

from left to right. This is equivalent to moving *W* and *X* through the field from right to left. Applying the right-hand rule for the direction of voltage, we find that the voltage generated in *W* is out of the surface of the paper and that in *X* into it. Hence the direction of the voltage in winding *B*, upon closing the switch, will be that indicated by the arrows in Fig. 2.

Since a voltage is created across coil *B*, it is evident that current would flow through a circuit if connected to it. If the switch *S* were to be continuously closed and opened with great rapidity, a pulsating voltage would be established across coil *B* that would cause a pulsating current to flow through whatever circuit was connected to it. It is therefore apparent that energy from generator *G* is being transferred to the resistance *R*, in spite of the fact that no electrical connection exists between the generator and the resistance. For the continual make and break of switch *S* we can substitute an alter-

nating current. By its use the current through C will continually be made to alternate back and forth, so that the effect is much like that obtained by means of the switch S. However, the switch arrangement is not practicable for anything but very small amounts of power, whereas with an alternating current large values can be handled with entirely satisfactory results.

The preceding problem dealt with a balanced 115-volt, two-phase, three-wire system, the load has a power factor of 88 per cent., each outside wire has a resistance of 0.00467 ohm, and the common wire carries 141 amperes. It was required to find the current in the outside wires, the apparent power, the actual power, and the loss in the outside wires. The current in the common wire of a balanced two-phase, three-wire system is equal to 1.41 times the current in either of the other wires; hence, where I_c and I_o equal the current in the center and outside wires, respectively, $I_c = I_o \times 1.41$, from which $I_o = \frac{I_c}{1.41} = \frac{141}{1.41} = 100$ amperes.

The apparent power is the sum of the apparent power in the two phases. The apparent power in each phase is $E \times I_o = 115 \times 100 = 11{,}500$ volt-amperes, or 11.5 kv.-a., so that the total apparent power is $2 \times 11.5 = 23$ kv.-a. The actual power is equal to the apparent power times the power factor. Consequently, actual power $kw. = 23 \times 0.88 = 20.24$ kilowatts. The loss in the lines is found from their resistance and the square of the current carried by them. Since I_o is 100 amperes, and the resistance of each of the outside wires is 0.00467 ohm, we have for the two wires, watts loss, $W = 2 \times I_o^2 \times R = 2 \times 100^2 \times 0.00467 = 93.4$ watts.

The load on a balanced three-phase system is 75 kw., the voltage between terminals 2300 and the power factor 0.65. Find the kv.-a. load and the current per terminal. If the generator's windings are connected in delta find the current per phase.

Fuel Saving in an Ice-Making Plant

By C. T. Baker

It was decided that the plant in question was using too much fuel and steam to produce the rated output, consequently an investigation was undertaken to determine, if possible, some of the causes for poor economy.

The boiler plant consisted of three 125-hp. return-tubular boilers and one compound condensing, Corliss-driven duplex, horizontal refrigerating machine, having two 17x34-in. double-acting ammonia compressors. The usual auxiliaries were installed and were supplied with steam from the boilers, which also furnished steam for reboiling distilled water for ice making. Before anything was attempted in the way of changes, an evaporation test was run on the boilers, all three being in operation at that time. The following results were obtained: Boiler horsepower developed, total for three boilers, 238; percentage of rated capacity developed, 79; water fed to boilers per pound of coal as fired, lb., 5.4; equivalent evaporation from and at 212 deg. per lb. combustible, 7.25 lb.; factor of evaporation, 1.1565; per cent. of ash and refuse in coal, 13.8.

At the completion of this test a careful survey of the plant was made to see wherein improvements could be effected. The first things examined were the boiler settings. It was surprising to note the condition of the brickwork. Holes, large and small, were in evidence everywhere about the settings, and cold air was passing into the furnaces and combustion chambers in large volume. The settings were put in first-class condition, after which the firemen were instructed in the proper handling of the fires and the use of the dampers. Little attention had ever been given to proper instructions in the boiler room and the dampers were never used, all draft control being effected by the ashpit doors.

The next step was the repairing of steam leaks, of which there were several bad ones. By this time it was possible to cut out one boiler, since the stopping of the steam leaks and getting the boiler settings tight had so improved things that two boilers could carry the load without trouble.

Carrying the investigation further it was found that two reboilers were used to reboil the distilled water for the distilled-water freezing tanks and to furnish distilled water for filling the cores in the raw-water air-agitated tank. As the total distilled-water requirements were in excess of the available supply, considerable raw water had to be used in the boilers to make up the deficiency. This was, however, of good quality and did not affect the clearness of the ice to any extent. The temperature of this water entering the reboiler was 80 deg., which of course had to be raised to 212 deg. in the reboiler before being delivered to the pre-cooling and storage tank.

To overcome much of this loss, this makeup supply was taken from the feed-water heater, the water leaving the heater at a temperature of 140 deg., which meant a clear gain of 60 deg., representing the saving of several thousand B.t.u. per 24 hours, depending of course on the condition and amount of raw water used. This change so reduced the work required in reboiling that one reboiler was found ample to properly boil the water, permitting one to be taken out of service.

A still further saving in fuel consumption was effected by substituting exhaust steam for live steam for heating the thawing water at the can dumps.

The steam cylinders, high- and low-pressure, of the compressor, were indicated and the valve setting improved. After making a few minor changes, the second evaporation test was run with the following results: Boiler horsepower developed, total for two boilers, 222; per cent. of builder's rating horsepower developed, 111; water fed to boilers per pound of coal as fired, lb., 6.09; equivalent evaporation from and at 212 deg. per pound of combustible, lb., 8.67; factor of evaporation, 1.1550; per cent. of ash and refuse in coal, 19; kind of coal each test, nut and slack; kind of furnaces, hand-fired.

As it was desired to know what percentage of the steam supplied was used to operate the compressor and what was required to supply steam to the auxiliaries, including the reboiler, a steam-consumption test was made on the main engine at the time of making the boiler tests. In the first test it was found that the steam cylinder of the compressor used 74.9 per cent. of the steam generated, and in the second test, after the changes had been made, the steam consumption was 77.3 per cent., or a difference of 2.4 per cent. The operating conditions, such as pressure, vacuum, speed, output, etc., were substantially the same for each test.

No means were at hand for determining the quality of the steam. However, as a matter of comparison and to show whether conditions were being improved, this information as regards steam quality is not absolutely essential. It should be stated that the steam consumption in the second test averaged 200 lb. per hour less than in the first test.

The low-grade bituminous coals available for fuel in this country vary in heat value from 8000 to 9000 B.t.u., where the high-grade coals vary from 14,000 to 15,000 British thermal units.

Westinghouse Marine Turbine Governor

WITH a speed regulation which, with a loaded vessel in bad weather, does not vary more than 2 per cent. above or below normal, nor more than 4 per cent. each way with the vessel running light, a marine turbine governor, Fig. 1, now in successful service, presents noteworthy features. It will not, under any circumstances, shut the turbine down, but will regulate the flow of steam to the nozzles in such manner that the speed is kept practically constant under all conditions. It is made by the Westinghouse Electric and Manufacturing Co. and is used on their turbines of the marine type.

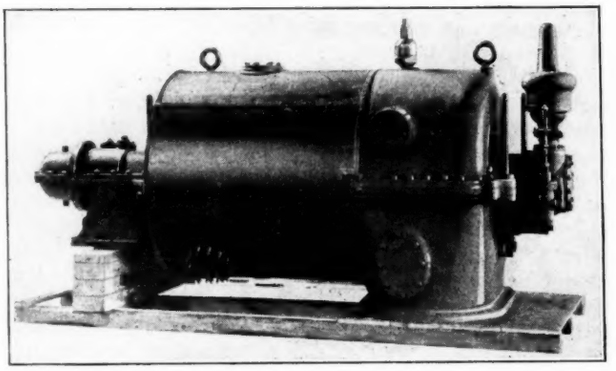


FIG. 1. MARINE TURBINE, SHOWING THE GOVERNOR

Referring to the diagram, its operation is as follows: A vertical spindle S mounted on the forward end of the turbine is driven by a worm gear on the mainshaft at a speed about one-quarter of that of the mainshaft.

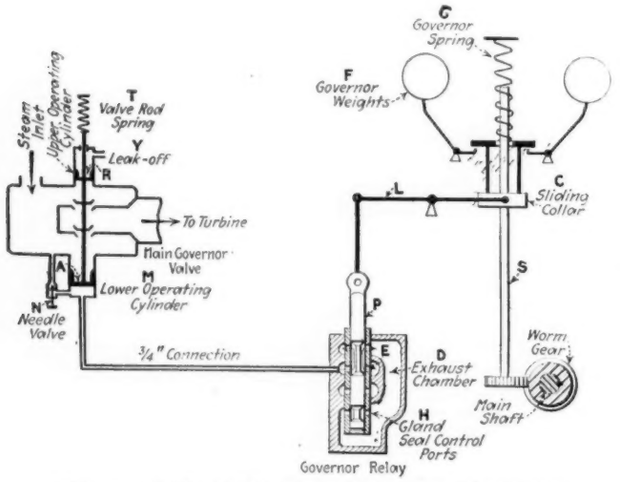


FIG. 2. DIAGRAMMATIC LAYOUT OF GOVERNOR CONNECTIONS

At the top of this spindle is mounted a flyball centrifugal device F of the familiar general type. As the speed of the turbine increases above normal and the governor balls are thrown farther away from their center, the sliding collar C is raised and accordingly actuates the relay lever L, whose fulcrum is near the center, as shown. The piston P of a steam relay valve is connected to the lever L and moves with it. In this case the piston is depressed, thereby uncovering ports E.

Attached to the ports E is a ¾-in. pipe connecting with the lower operating cylinder M of the main governor valve. This valve is of the double-disk balanced poppet type. On the bottom of the valve stem there is a piston A. A second and smaller piston R is fitted to the top of the valve stem. The rod of piston R extends through a stuffing-box and is attached to one end of a compression spring T. These parts are connected together through flexible joints so as to permit the valve to seat squarely and without restriction.

When the turbine is operating under normal conditions, the governor valve is held wide open. The pressures on both sides of the piston A are balanced, that beneath the piston being maintained by leakage past the piston together with the steam supply admitted through a small opening in the needle valve N.

The upper piston R is unbalanced, the lower side being exposed to steam from the boilers, while the upper side is open to the atmosphere through the leak-off pipe Y. The downward thrust of spring T tending to close the valve is therefore overcome by the upward

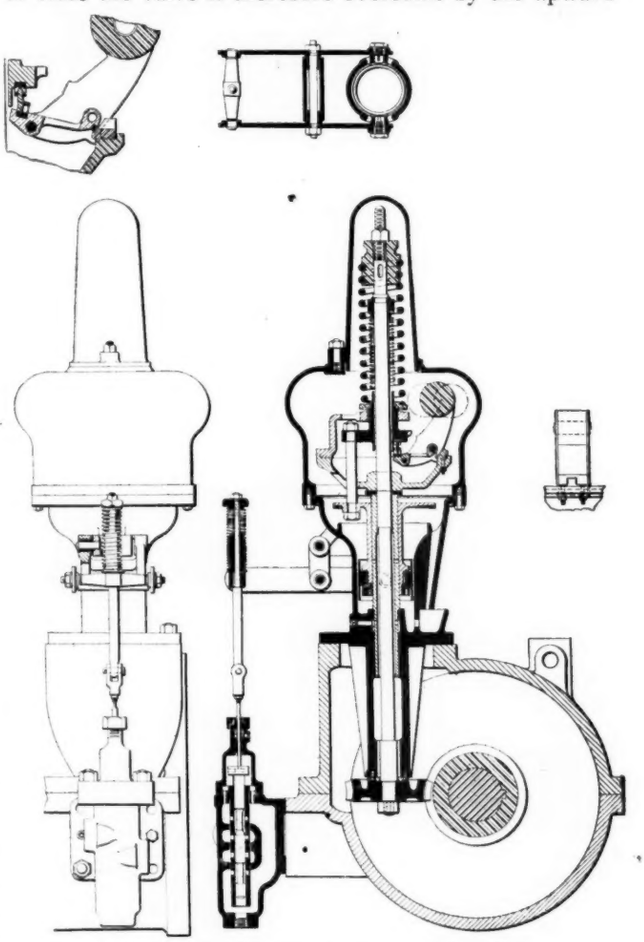


FIG. 3. THE GOVERNOR AS CONNECTED

thrust of the steam on piston R, and the valve is held open.

However, as the relay piston P is depressed, opening the ports E, a passage is opened from the lower side of piston A to the exhaust chamber of the relay. This destroys the balance of piston A, and the boiler pressure on the upper side of the piston, aided by the downward thrust of the spring T, overcomes the upward

pressure of the steam against the lower side of piston *R*, and forces the valve downward, reducing or temporarily shutting off the steam supply to the turbine.

As the speed slows down to normal, the governor weights *F* move inward under action of a spring *G*, raising the relay piston *P* and closing the exhaust ports *E*. The steam pressure under the main governor valve piston *A* is accordingly raised, and the piston moves upward again, opening the main valve as far as may be

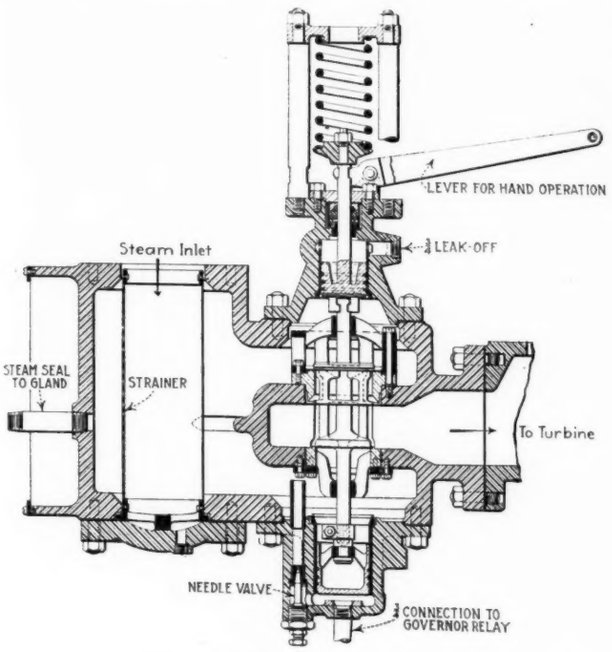


FIG. 4. THE GOVERNOR VALVE.

necessary to admit steam enough to maintain the speed of the turbine at normal.

Another feature of the governor is an arrangement for the automatic control of the steam and water supply to the glands, which prevent leakage where the rotor emerges from the casing on both the high- and low-pressure turbines. The glands are of the combined steam- and water-sealed type. The water gland is designed to effectively seal at all speeds from and above half-speed. Below half-speed the steam seal is used.

To accomplish the gland-seal control in addition to its function of speed regulation, the travel of the governor weights is divided into two zones, one corresponding to a slow turbine speed and the other to a fast rate, the zone division being made possible by two concentric springs on the upper end of the governor spindle. The slow zone spring is smaller and lighter than the other and is placed inside the larger spring. The inner, or slow, travel of the governor weights is opposed by the light spring only. While the turbine is operating at the speed which corresponds to this zone of governor travel, steam seal is used. However, as the speed increases, a point is reached where the steam seal is changed to water, the change being accomplished by incorporating in the governor relay an extra set of ports *H* which, with the relay piston *P*, operate a valve for the control of the sealing function in a manner similar to that in which the movement of the main governor valve is controlled. Fig. 3 is a section of the governor and Fig. 4 a view showing it connected to a marine turbine.

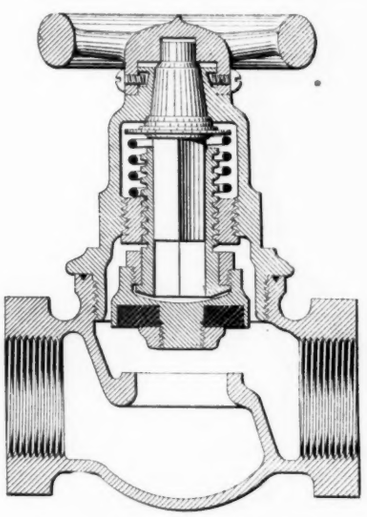
The change from steam seal to water seal takes place at the point where the fast spring zone comes into engagement with the governor weights. The speed continues to increase, however, until the governor takes up its main function of regulating the steam supply to the turbine.

While no attempt is made to obtain extremely close regulation, such as is needed on electric-generator drives, it has been found that the marine governors are very positive in their action and hold the speed of the turbine within very reasonable limits.

Defiance Packless Valve

A packless valve with a metal-to-metal seat at the top of a nonrising stem has been perfected by the Defiance Packless Valve Co., of St. Louis, Mo. It is adaptable for steam, hot and cold water, radiator service, oils and acids. The accompanying illustration shows in section a valve designed for 250-lb. steam pressure. The valve has a one-piece bonnet that is interchangeable with practically all valve bodies on the market.

No packing is employed. The stem acts as a key to raise and lower the valve disk. It is double-seated in the bonnet at angles of 10 and 30 deg. and is held against the seats by a spring. The valve stem is made square in cross-section and of metal harder than the bonnet, to take care of expansion and contraction and to guard against cutting or grinding. Underneath the spring is a threaded sleeve screwed to the bonnet. Within is a second threaded sleeve into which the valve stem enters and to which the valve disk is attached at the lower end. It will be apparent from the construction that turning the handle will raise or lower the valve disk without imparting a similar movement to the stem.



DEFIANCE PACKLESS VALVE

If steam should get past the threaded joint between the sleeve and the bonnet, it will supplement the action of the spring in holding the stem tight against the seats in the bonnet. The valve is dustproof, as the handle plate rests upon the bonnet and is interlocked with it. Another feature is the V-shaped projection on the lower surface of the bonnet shoulder. This jams into the seat on the valve body to form a steam-tight joint.

All of the most successful insulating varnishes are what are known as baking varnishes. Many attempts have been made to produce air-drying insulating varnishes, but up to the present time these have only been successful to a limited degree.

Experience of an Erecting Engineer—Pressing Alternator's Rotor on Shaft

By KENNETH A. REED

Describes in detail how a shaft, 0.025 in. over size, was pressed in the hub of an alternating-current generator's rotor, with inadequate equipment for doing the job.

OCCASIONALLY, an erecting engineer is called upon to do a job that proves to be far more difficult and requires a much greater expenditure than was expected when the estimate for doing the work was made. Perhaps under ideal shop conditions, where every facility, such as a traveling crane, a hydraulic press of proper capacity, calipers of suitable size, various other tools and, last but not least, experienced labor for doing the job, are at hand, it would simply be one of many such operations in a day's work. However, when the same job comes up on the outside, where single pieces weighing several tons are to be handled with a crane of insufficient capacity or no crane at all, and the use of jacks and a large amount of blocking must be resorted to, the problem oftentimes assumes a serious aspect.

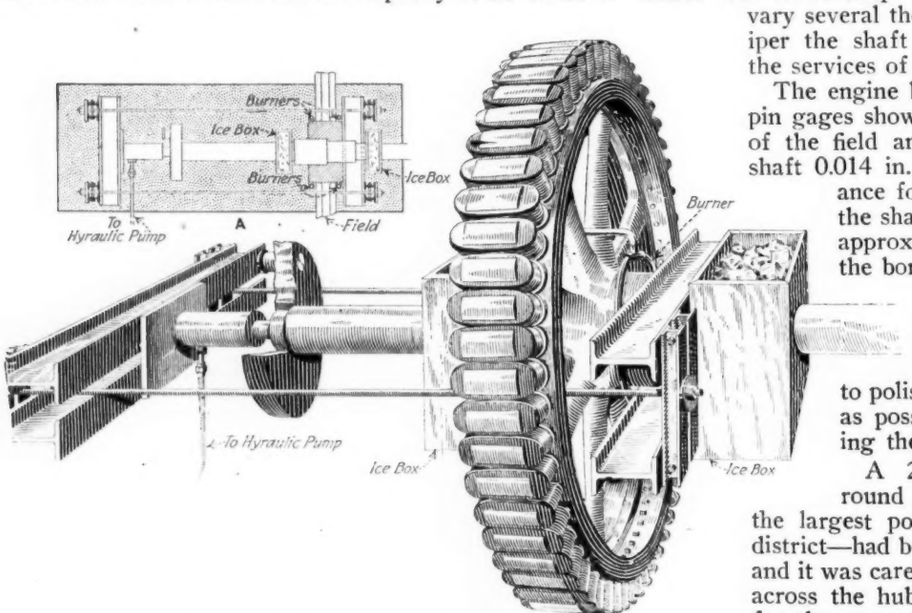


FIG. 1. EQUIPMENT IN PLACE FOR PULLING ROTOR ON SHAFT AND ICEBOXES

One of the most difficult of such jobs that I was responsible for was the pressing of an engine shaft into the field of an alternator. The engine was of the usual cross-compound Corliss type, operating at about 75 r.p.m. The shaft was 26 in. in diameter and weighed approximately 17 tons. The field of the generator was about 14 ft. in diameter, the hub, spokes and rim being a single steel casting with the laminated field poles secured to the rim by means of dovetails and wedges. The complete field weighed approximately 15 tons. The length of the hub was about 18 in., and it was bored to two diameters, as shown at *A*, Fig. 1. That is, one half of the hub was bored to, say, 26 in., and the other half to 26¼ in. The hub seat on the shaft was, of course, turned accordingly, allowance being made for press fit on both diameters. The actual distance that the shaft had to be pressed into the hub was therefore only one-half the length of the latter, while a uniform pressed fit was secured through its entire length.

Under the terms of the contract the manufacturer was to furnish an engineer together with necessary labor and tools for assembling the machine, and arrangements were made whereby some of the customer's laborers could be used. No calipers of proper size could be obtained in the locality where the job was being done, and it was necessary to hire the services of a machinist from a large manufacturing company, which was supplied with such calipers for its own use, in order to check up the diameter of the shaft. It might be explained here that calipering a very large shaft is a rather particular job, inasmuch as the heat from a man's hands will cause calipers of such size to expand and vary several thousandths of an inch. To caliper the shaft correctly, therefore, required the services of an expert in that line.

The engine builder had been supplied with pin gages showing the exact bores of the hub of the field and was instructed to turn the shaft 0.014 in. larger to make proper allowance for a press fit. Upon calipering the shaft, however, it was found to be approximately 0.025 in. larger than the bores of the hub. In view of the fact that it would be practically out of the question to remove the 0.011 in. oversize from the shaft, it was decided to polish both shaft and hub as smooth as possible and take a chance on doing the job.

A 250-ton hydraulic press with round pull-rods 3½ in. in diameter—the largest portable press in the immediate district—had been secured for doing the work, and it was carefully set up, using 8-in. I-beams across the hub of the field and as backstays for the ram of the press, the pull-rods being connected to these two sets of I-beams. The shaft was so long that only one end could be handled by the crane, and this end was the one on which the crank disk had been pressed at the engine works, the other disk having been left off until the shaft was pressed in; therefore it was necessary to support the other end of the shaft on cribbing.

After the key and keyway had been carefully lined up, the exact distance the shaft had to be pressed in marked, and the shaft and hub painted with white lead, the hand pump of the press was started. It seemed as though the plunger of the ram had barely come up against the shaft before the 8-in. I-beams failed. This, of course, necessitated taking the press down and installing larger I-beams. This time 16-in. beams were used, and the shaft went in very nicely for about 3 in., when it practically quit moving, and the pressure, on

the press, increased to 145 tons. At this point one of the 16-in. I-beams across the hub failed, and serious troubles began.

In order to make sure that no failure of beams would again occur, it was decided to use 20-in. extra-heavy I-beams across the hub, and behind the ram, with two 10-in. extra-heavy I-beams bolted together and resting across the 20-in. beams, forming the anchor of the pull-rod, as shown in Fig. 1. These beams could not be secured and placed in position until the following day, which of course helped to make the condition worse, since once a shaft is started into the hub it should be kept moving until in place. If for any reason the shaft is stopped, a greatly increased pressure is required to get it started again.

On setting up the press the third time, the distance between the cross-beams was measured accurately at each pull-rod, in order that there would be no unequal strains on the two pull-rods, which might cause trouble. Everything being in readiness, the pump was started and the pressure rose to 260 tons, its maximum safe limit, without the shaft giving any indication of starting. It was then decided to suspend an oak timber 9 in. square and about 20 ft. long from the roof of the power house and use it as a battering ram against the end of the shaft to get it started. Six or eight men were put on the timber, and they swung it back as far as they could and rammed the end of the crank disk, the pressure on the ram still being maintained at 260 tons. The result was anything but that which was desired, and for a few minutes seemed to have been disastrous. Instead of the shaft starting, one of the pull-rod nuts, which was more than 6 in. long, failed with a report like that of a cannon, and the cross I-beams on the pump end swung around, injuring the feet of three of the men who had swung the battering ram. These short I-beams, weighing about 200 lb., against which the nut that failed pulled, were thrown directly back a distance of 20 ft., and landed in a condenser pit. Fortunately, the attendant was watching the job instead of attending to the condenser, and after calling the roll it was a delightful sensation to realize that there were no serious casualties.

The prospects were now not very promising in view of the difficulties that had arisen and the fact that the customer was in a big hurry for the machine. However, no time was lost in unnecessary conjecturing, and the problem reduced to one of two things—either secure by express a 500-ton press from a distant district, or devise, on the job, some as yet untried method. The first solution, while being without doubt a certainty, had two serious objections—one being the loss of time necessary to get the press and the other the excessive expense for express charges. These objections made it necessary to adopt the second solution.

During the period of consideration it was remembered that engineers had put in place by contraction bridge spans that were too long and by expansion those that were too short, so it was decided to try such a scheme in this case. Accordingly, boxes were built around the shaft on each side of the hub and packed with ice, as shown in Fig. 1. While the shaft was being chilled, two circular burners, shown in Figs. 1 and 2, were made for the purpose of heating the hub of the field, one being placed on each side, and as near to the spokes as practicable. These burners were made of ¾-in. pipe with $\frac{1}{16}$-in. holes 3 in. apart on the inner side, and the size of the circles was such that the clearance between the burners and the hub was about 3 in. all around. The burners were then piped to a tank and a connection to the compressed-air line in the power house. A piece of pipe about 4 in. in diameter and 16 in. long was placed in the ¾-in. line about halfway between the burners and the tank; and a blacksmith force was placed immediately under this large pipe, as in Fig. 2. This was for the purpose of preheating the oil before it reached the burners.

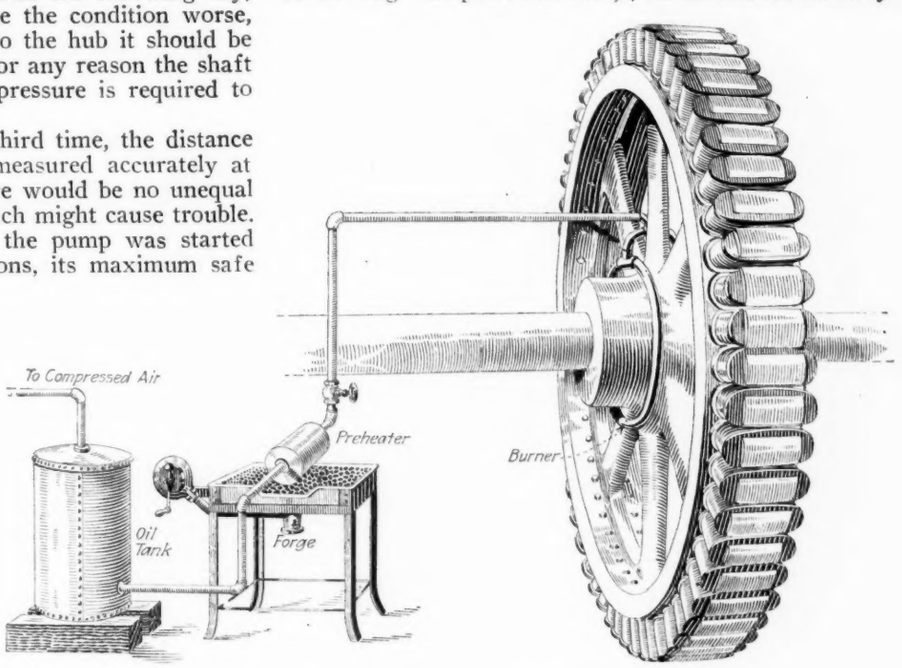


FIG. 2. ARRANGEMENT OF HEATING DEVICE

An additional nut for the pull-rod had been secured, the press set up again, and all checks possible were made to see that everything was just right. Air to the tank was turned on, and after heating the preheater of the feed pipe for some minutes, the burner valve was opened and a torch applied to the burners. Results at this juncture were simply astounding. The entire cribbing and lower part of the field burst into flame, and excitement began to run high. However, no great alarm was felt for the safety of the apparatus, inasmuch as one end of the shaft, as before mentioned, was supported by the crane, and new cribbing could have been placed under the other end had the fire been serious. An ineffective attempt was made to prevent a fire alarm being turned in; fortunately, however, before the fire fighters arrived the blaze had been extinguished without the use of water. An investigation disclosed that gasoline had been used in the tank instead of crude oil as ordered, and that part of the feed pipe beyond the preheater had filled up with gasoline as soon as the air was turned on, and this gasoline had trickled out over the cribbing when the burner valve was opened.

Crude oil was substituted for gasoline, and the burners were successfully lighted without further mishap. The pump of the press was started soon after, and within ten minutes from the time the burners were lighted the shaft began to move under a pressure of

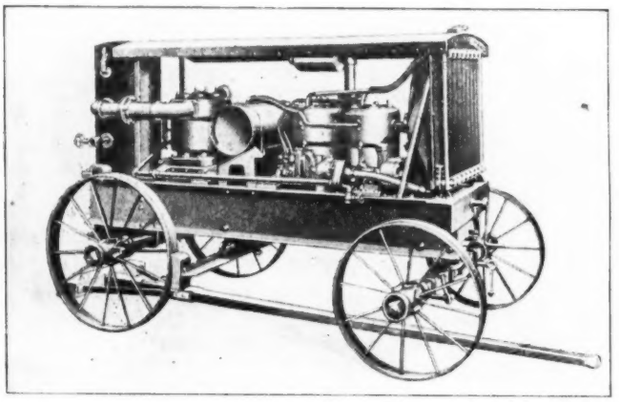
175 tons. Immediately after the shaft started, the pressure dropped to 75 tons, and it remained at from 75 to 90 tons until the shaft was in place. These pressures checked up quite close with calculations made before this scheme was adopted, when it was figured that if a difference of temperature of about 12 deg. could be secured between the hub and the shaft, the press fit would be reduced sufficiently to require not over 100 tons pressure after the shaft had been once started.

Portable Air Compressor

This portable air compressor is all of steel, from its canopy to its broad-tired wheels. The power plant consists of a duplex, vertical high-speed compressor driven by a four-cylinder, four-cycle, tractor-type gasoline motor. The large machine, of 210 cu. ft. capacity, weighs 6000 lb., and the 118-cu. ft. units 4000 lb. The compressor has cylinders cast *en bloc*, with cylinder heads, valve chambers and water-jackets integral. Both intake and discharge valves are of the plate type and are located directly over the cylinder bore. Crankshaft and connecting rods are drop forgings, the air pistons are fitted with three-piece piston rings and, in addition, with an oil-wiper ring. All parts are lubricated by splash from an oil reservoir in the crank case.

The compressor is provided with an inlet unloading device which automatically closes the compressor intake when the receiver pressure rises above a predetermined limit, and permits the machine to take up its load again when the pressure has fallen a definite amount.

Both compressor and driving motor, which are manufactured by the Ingersoll-Rand Co., 11 Broadway, New York City, are water-cooled by a circulating system, with a centrifugal pump, large radiator and powerful blast fan. The radiator is made up of removable sections.



PORTABLE AIR COMPRESSOR

Each unit is equipped complete with receiver, safety valve, drain valves, pressure gage and service valves to which the air-hose lines may be attached.

Motor installations made on 2300-volt circuits have in general been considered more of a fire and personal hazard than low-voltage installation. However, experience has shown that 2300-volt installations when made as required by the National Board of Fire Underwriters' code are as safe as the low-voltage circuits. There is little or nothing on record to show that anyone has received a dangerous shock on the motor side of the distribution switchboard of 2300-volt motor installation.

Alternating Current Motor Starting Switch

It is permissible to start induction motors up to and including 5 hp. and in some localities 7½ hp. by connecting the motor directly to the power circuit. Induction motors of these sizes can be started in this manner without injury. In the past it has been customary to start these motors by simply closing a knife switch or similar device. A new contrivance for this kind of work has been developed by the Electric Controller and Manufacturing Co., of Cleveland, Ohio, to make the starting of these motors foolproof. This device is known as an alternating-current starting switch, is operated by a push-button, and is inclosed in a steel cabinet as shown in Fig. 1, with conduit connection for all wires. A compact push-button arranged for conduit connection, as shown in Fig. 3, is supplied for "starting" and "stopping" the motor. Fig. 2 shows the starting switch with the cover of the box open.

FIG. 1. SHOWING COVER CLOSED

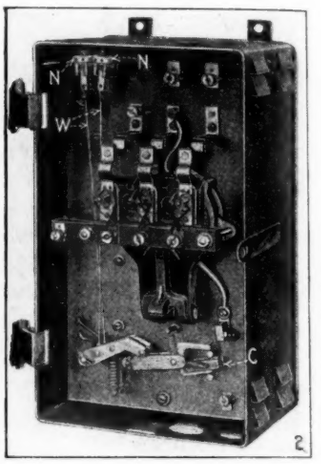


FIG. 2. SHOWING COVER OPEN

The two wires *W*, Fig. 2, extending the length of the slate on the left-hand side, give overload protection of the inverse-element type, both while the motor is starting and while it is running. The principle used is one entirely new in motor-starting practice, but is the same as used in hot-wire ammeters and voltmeters and gives an extremely accurate overload protection, at the same time giving an inverse-time-element feature. These two wires are stretched, and the operating value of the overload protection is adjustable by changing the tension of the wire by the nuts *N*. If too much current is being taken by the motor, these wires will expand, causing the small contact *C* at the bottom to be open, and this will in turn deënergize the magnet coil and cut the motor off the power line. It is then necessary to push the start button before the motor can again be started.

FIG. 2. PUSH BUTTON

The "safety-first" feature is incorporated in the switch in that the cover in the switch box may be locked and only authorized persons have access to the interior. The motor is started by pushing the "start" button and stopped by pushing the "stop" button. There are no laminations used in any part of the switch, and it is built in sizes up to 3½ hp. for 110 volts and up to and including 7½ hp. for 220, 440 and 550 volts.

EDITORIALS

Combined Issues

SOME five or six weeks ago, when the strike of New York printers had apparently reached a hopeless deadlock, arrangements were made to print *Power* in Chicago, where it is now being handled. In order to catch up with the schedule by the first of the year, it was decided, as previously announced, to combine, two in one, each of the remaining issues of the present volume. But this decision was later affected by the coal shortage, from which Chicago was one of the cities most threatened, because of its almost exclusive dependence upon bituminous coal. As a precautionary measure the regional fuel director cut the working day to six and a half hours in addition to other drastic restrictions.

Therefore, in order to catch up by the first of the year, the *Power* schedule was further modified so that each of the two last issues in December will be a combination of three numbers, the present one including the November twenty-fifth, December second and December ninth, and the final issue the December sixteenth, twenty-third and thirtieth. The sizes of these combined issues have been increased accordingly, so that the reader will receive what ordinarily would have come to him had there been no strike.

Unconscionable Profits

THE prosecution of Western oil producers on charges of profiteering has been ordered by Attorney General Palmer. Senator Copper says that they have increased their prices from about a dollar a barrel before the strike to four dollars and a half a barrel.

William G. McAdoo, former Secretary of the United States Treasury, says that in 1917 the mine owners made "shocking and undefensible profits" on bituminous coal. He saw their income and excess-profit tax returns. They showed earnings on capital stock, he says, ranging from fifteen to two thousand per cent. Earnings of from one hundred to three hundred per cent. were not uncommon.

The bituminous coal operators admit that profits were abnormal in 1917, but claim that the Government promptly put an end to them. How abnormal they were and how promptly the Government put an end to them is shown in tables and charts given in bulletins issued by the Geological Survey and the Federal Trade Commission.

Harry A. Garfield, Federal Fuel Administrator, says that the average realization upon 579,385,820 tons of bituminous coal mined in 1918 was $2.61 per ton; that the average cost of production during the same period was $2.15 per ton; that the margin of 46 cents per ton does not include interest charges, selling expense, Federal taxes, etc. The average income and excess-profit taxes for 1918 were upward of 30 cents per ton.

Hon. Carter Glass, Secretary of the Treasury, says:

> Coal operators generally in the United States in the years 1914 and 1915 lost money when normal depletion and depreciation are taken into consideration. What is meant by this is that a proper item in fixing costs is depreciation of plant and depletion of the cost or value of the coal in the ground.
>
> In the latter part of 1916 all coal companies in the United States, save those in the extreme West, began making money, with the result that the operations for the year 1916 generally show a profit of from 10 to 35 per cent. on capital invested.
>
> In 1917 all bituminous coal mines east of the Mississippi River made what might be termed fabulous profits, the general average being from 100 to 150 per cent. on invested capital, the range being from 15 to 800 per cent.
>
> In 1918 conditions were not so good in the Appalachian and central competitive districts, profits generally being reduced 25 to 30 per cent. less than for the preceding year, the range being from 15 to 300 per cent. on invested capital. In the West conditions in 1918 were better than in 1917, the profits in the Rocky Mountain Districts ranging as high as 400 per cent. on invested capital.
>
> Unofficial figures for 1919, incomplete of course, indicate the profits of the operators are less than for 1918, some of the operators claiming to have actually lost money.

J. D. A. Morrow, vice president of the National Coal Association, says that for the entire bituminous industry to make profits of from 100 to 150 per cent. would require a total profit of upward of $1,500,000,000. According to the United States Geological Survey Report, "Coal in 1917," he says that the total gross receipts of the operators for all the bituminous coal produced in 1917 was only $1,249,272,837. Hence he says the total gross receipts, before deducting operating expenses, were less than the alleged profits.

The total number of tons of bituminous coal mined in 1917 was 551,790,000. If the foregoing statement of gross receipts is true, the average selling price must have been $2.26 per ton.

The operators say that they will welcome the publication of "just as full current tax returns for the bituminous-coal industry as are published from any other industry," and Mr. Morrow requests Mr. Glass to "also publish for other industries their average percentage of profits both before and after Federal taxes have been paid."

District representatives of the United States Government filed in the Federal Court at Pittsburgh on December 8 a suit against the Transcontinental Oil Company, of that city, in which it is claimed that the concern had charged unjust and unreasonable prices for fuel oil. The allegation is made that the officials named sold fifteen thousand barrels of fuel oil for three dollars a barrel. Several other sales are cited.

Attorney General A. Mitchell Palmer says that up to the end of October, 1919, there had been ninety-two cases of seizure for profiteering in foodstuffs. In addition twenty-two instances of alleged hoarding have been reported and instructions issued to seize the goods and prosecute the offenders if the facts warrant such action. Approximately 4,800,000 dozen eggs, 1,700,000 pounds of butter, 2,500,000 pounds of meat and 20,000 cases of canned goods were included in these seizures.

Bradstreet's "index number" of commodity prices on December first sets the highest average prices yet recorded, and now stands at 131 per cent. above prewar levels.

The readers of *Power* are the largest purchasers of fuel. They are entitled to know the cost of its production and how that cost is made up: How much they are paying for the coal in the ground (the depletion charge) and how much the producers paid for it; how much

years, after which we shall have to depend upon coal entirely for fuel. The industrial centers that now feel the effects of the present fuel situation will feel it even more when the supply of fuel oil has become limited.

There is apparently one logical direction in which to turn, and that is to the more complete development of the water powers, especially in the industrial districts, and the improvement of those that have been so uneconomically developed in many of the manufacturing centers. Instead of the three or four low-head developments, producing in the aggregate only twenty-five to fifty per cent. of the power available, there should be one development utilizing a maximum head and producing the greatest amount of power available at each site. There are a number of ways in which this could be done. The most satisfactory, no doubt, would be for the manufacturers that control the water rights to coöperate to the end of making the development either through a company of their own interests or in conjunction with some public-utility company. Necessity is the mother of invention, and doubtless necessity will in the near future bring about the economical development of many of our water powers that have been developed along the lines of least resistance and as a result are now producing only a small part of the power available.

Co-operation As a Factor In Improving Power Service

WHEN power is supplied from a direct-current system, the public utility to a very large extent controls all the factors that contribute to a satisfactory service. The power factor of this system is unity under all conditions of load, the starting currents taken by motors are generally not over 125 or 150 per cent. of normal full-load current, and in most cases the feeders are short. Consequently, their inductance is low, and any sudden changes in the load do not cause serious voltage drops near the load, the fluctuation being readily transmitted back to the source of power. Even where starting conditions are severe or where motors are stopped and started frequently, such as on elevators and hoists, the effect of the frequent starting and stopping is not very likely to be noticeable on the system voltage, since high-torque motors are generally used; consequently, the accelerating period is short and the starting current is not excessive. However, in alternating-current systems, the power factor is determined by the character of the customer's load. If the power factor of these loads is low, the volt drop in the line is high for a given kilowatt load. Not only does low-power factor cause excessive voltage drop in transmission and distributing circuits, but it also aggravates conditions by its effect upon the voltage regulation of the transforming and generating equipment. In an alternating-current system, owing to the inductance of the circuit and the low power factor of the load, the volts drop may be 200 or 300 per cent. that in the direct-current system when transmitting the same kilowatt load. The direct-current motor is capable of developing 100 per cent. full-load torque on 100 per cent. full-load current, where with a squirrel-cage-type induction motor as high as 400 per cent. full-load current is required to produce full-load torque. Consequently, if the motor is of comparatively large size, serious disturbances will be caused in the line. This starting current is always at a low power factor, which, in addition to causing excessive voltage drop in the system, seriously affects the regulation of the transformers and regulators.

From the foregoing it is evident that the character of the customer's load has a marked effect upon the kind of power service that may be rendered from an alternating-current system. The power company can install equipment on the system, and does in some cases, that to a certain extent partly overcomes the effects of poor load characteristics, but this all adds to the cost of generating, transmitting and distributing power. The rate for power is controlled in most localities by public-service commissions, and where these commissions are shown that an increased rate is justified, it is generally granted. Therefore, any additional expense that the customer's load may contribute to the cost of producing and distributing power will eventually be reflected back in a higher rate, either in a demand charge, a penalty for low power factor or an increase in the general rate.

Evidently, there is an opportunity for coöperation between the power customer and the central-station company, which will be of benefit to both parties. Already many of the power companies are endeavoring to cooperate with their customers, with a desire to render them an improved service. Unfortunately, not infrequently this coöperation had been looked upon by the customer as something that was to the benefit of the power company only. Two of the most common causes of poor load characteristics met with, are too large size and improper application of motors. Experience has reached a point in industrial application where both of these can be avoided to a very large extent by the proper consideration of the conditions to be met before the making of the installation. With the increasing cost of everything required to generate and distribute power electrically, anything that the power purchaser can do to keep down the cost at his end of the line will have a stabilizing effect in rates as well as help to improve the service.

Costs in Changing From Oil to Coal

ENGINEERS and executives of large power plants, industrial and public utility, are as never before interested in the cost of changing from oil to coal. Some plants are so favorably situated that the cost, in its relation to the duration, price, and delivery assurance, would, even now, form a good investment. These plants are by no means many. One large public-utility plant in New England, for example, happens to be virtually next door to an area which is now covered with tank farms and which will soon be one of the greatest oil depots in the world. This station probably will be burning oil before this gets into print—preparations have all been made. Here no great expense for storage facilities are incurred.

But in plants less favorably located, the cost of storage tanks may make the change of fuels prohibitive. There is great need for cost data and general and detailed considerations of costs bearing on the subject. The figures and considerations should relate to both steel and concrete tanks, to plants on tidewater and inland, to load factors, insurance requirements, etc.

The men who want these data are *Power* readers. We are, of course, anxious to serve them, and to this end we here encourage those who can contribute something worth while to do so. But have in mind that we do not confine ourselves to large plants; costs relative to the small ones are just as urgently needed.

Our observations in New England show that the actual costs in effecting the change are considerably greater than the estimated costs.

CORRESPONDENCE

Engine Crosshead Pounds

In the article "Engine Crosshead Pounds," page 477 in the Sept. 16 issue, Mr. Reed has described a condition that is frequently met with in heavy-engine operation; that is, greater compression is required on the head end than on the crank end. His explanation that the theoretical dead-centers are not the actual ones will not go far in explaining the trouble, as this would require a greater deviation from proper alignment than would be possible in any standard engine designed for true alignment.

I have found this same condition in heavy Corliss engines, and I have explained it in this way: The piston and crosshead with the piston rod move faster when traveling near the head-end center than they do when near the crank-end center. This faster speed produces greater inertia forces, which require greater compression to cushion and relieve the bearings from the pounding action of the reciprocating parts.

If any reader questions this statement and wishes to test it, all that is necessary is to take a horizontal engine and mark the mid-travel position of the crosshead; that is, put marks on the crosshead guide corresponding to the position of the crosshead when the piston is equally distant from both ends of its travel. Then look at the crank and note its position. It will be found that the crankpin is considerably off the vertical line of the center of the crankshaft.

Turning the engine over one center and bringing the crosshead to mid-position again will bring the crankpin directly over or under its position when the crosshead was in mid-position before. This vertical line of crankpin positions when the crosshead is in mid-position will be considerably nearer the crosshead than the vertical center-line of the crankshaft. Then put the crankpin on vertical center-line of the crankshaft and note the position of the crosshead; it will be found to be much nearer the crank-end dead-center. If still in doubt, put the crankpin in the opposite position, but still in the vertical center-line of the crankshaft, and it will be found that the crosshead is in the same position as before, or nearer the crank-end dead-center.

With a heavy flywheel there is almost uniform circular motion of the crankpin, which means that the same time is consumed in passing from the top to the bottom position on the vertical center line of the crankshaft as is consumed in passing from the bottom to the top position. But during this time the crosshead has not been moving the same distance in both cases, for it has a shorter distance to travel in going to the crank-end center and back than it has to travel in going to the head-end center and back to its position corresponding to the vertical position of the crankpin. If it has to travel farther in the same length of time, it must travel faster.

This same condition causes a difference in the diagrams from the two ends of a slide-valve or piston-valve engine. If the valve is set for equal leads, the head-end diagram is always greater than the crank-end diagram because the cutoff is later and not because the valve moved slower, but because the piston moved faster and so got farther in its travel before cutoff occurred.

Peoria, Ill. C. E. MOULSON.

Superheated Steam—Why Not?

In the Sept. 16 issue, page 475, I read Robert H. Wyld's letter on Superheated Steam—Why Not? I also read the editorial relating to the same subject under date of July 1.

It is natural for a man in the business to recommend his apparatus, but the operating engineer has to keep his plant running during working hours and either make or superintend repairs. It has been my experience that superheated steam is not good for a flat valve. I took a plant of several thousand horsepower capacity where large reciprocating engines were used. The valve gear showed signs of intense distress, although plenty of cylinder oil was used. An examination showed that the oil was not lubricating properly, so I decided to use a compound product, but of course I knew that I would have to sacrifice superheat to do it.

We cut the superheat down to about 30 deg., and then the oil got to the valve seats. The valve gear eased up and everybody was happy, and the cost per kilowatt-hour did not run up either. I am a believer in superheat, but I do not want it on large units of the flat-valve or Corliss type regardless of what others may do or have done.

I know of one generating station where Corliss engines were operated for years with excellent success. A large turbine was installed, something like 15,000 or 20,000 kv.-a., and of course superheat was necessary. After the load dropped, at about midnight, the Corliss units were put on the line, but the valves acted queerly and would not drop. The night shift were put to all kinds of trouble, but the chief was a man of experience. His duty was to keep juice on the line twenty-four hours per day, seven days per week, and he was equal to it.

He simply introduced a little jet of water on the Corliss side of the steam main, and the engines pulled their load as formerly. Mechanical engineers told how to remedy the trouble and salesmen gave advice, but the chief just kept the juice flowing, also the little jet jetting.

C. W. PETER.

New York City.

Boiler-Tube Failures

S. B. Applebaum, in the Sept. 16 issue of *Power*, says: "By changing from the common name of 'boiler compound' to the more fancy term, 'treatment,' and using the vague description, 'having a caustic base,' Mr. Weaver feels reassured." In reply I would say that I have tried almost every "boiler compound," as well as graphite, with considerable loss of time, patience and boiler tubes. Then I tried mechanical methods alone, and got along all right as long as I had soft spring water containing not more than 4½ grains of scale-forming materials per gallon. When I ran into water containing 22 to 25 grains of solid matter per gallon, I was glad enough to turn the problem over to a concern that had made a practical study of feed-water treatment.

Mr. Applebaum also says that the only real cure is to soften the feed water, and further that a water-softening plant can be so operated that there is no greater excess of "caustic base" left in the water than the amount put into the boiler as compound. Now the truth of the matter is, that the use of softeners even when they are operated ideally does not make it unnecessary to turbine the tubes. We find the large plants turbining their tubes just as the smaller plants; besides, some of the large plants I have in mind have plenty of trouble from an excess of soda. I am sure all engineers, including myself, would welcome that *ideal softener* which would cure all boiler-water troubles.

Warren D. Lewis thinks I am pessimistic regarding tube failures, especially those due to floating scale. It isn't pessimism to face facts. I have seen a great many tubes fail in horizontal water-tube boilers after the boilers had been let down and then fired up again without turbining the bottom rows. I want to emphasize again the necessity of turbining the two bottom rows of tubes *every* time the boiler is shut down. Turbine all the tubes if possible, but be *sure* to clean the two bottom rows.

Mr. Lewis' experience in losing 84 tubes due to neglect of turbining backs up my arguments. I recently cut into some burned tubes with an oxyacetylene torch before they had been removed. In every case I found a patch of hard scale about $\frac{1}{16}$ in. thick inside the tube at the point where it had bagged. This scale had evidently been skipped over by the turbine cleaner.

If turbine cleaners alone will prevent the loss of tubes, no other expense is necessary. If, however, time and facilities for thorough turbining are not available, it is advisable to have the water analyzed and to purchase a treatment or compound suited to the individual conditions. If the plant is large enough, a softener is essential.

WALDO WEAVER.

Franklin, Ohio.

Wiring a Lifting Magnet

After considerable trouble and time wasted with our lifting-magnet wiring, we have devised what I believe to be one of the best possible arrangements for carrying the current from the stationary part of the locomotive crane to the magnet. We first tried the method, Fig. 1, of carrying duplex wire from the magnet through a sheave in the end of the boom, to a swivel sheave mounted on top of the crane cab, looping downward through a sheave and counterweight, (to take up the slack in the cable when the magnet is hoisted), thence over a sheave and to the circuit-breaker.

This all looked very fine until put into use; then many kinds of trouble developed. The swivel block, which was expected to turn with the turning of the boom, remained in one position, and this caused the duplex cable to chafe on the iron parts of the block, wearing off the insulation until the cable became grounded. Therefore it was decided to try the scheme shown in Fig. 2, and this has proved highly satisfactory.

Starting at the circuit-breaker, the current is carried by two No. 8 rubber-covered stranded wires run in conduit to the front of the cab, then is dropped down below the level of the bull wheel and carried out three or four inches beyond, where the wires are brought out of the conduit through an approved conduit fitting and looped up to the boom, as shown at *A*, where they again enter conduit and are carried on the boom to the point

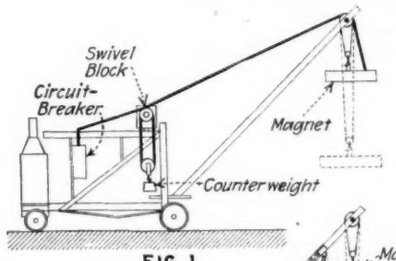


FIG. 1

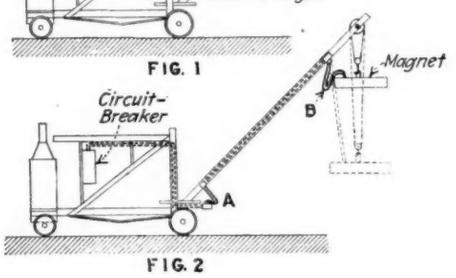


FIG. 2

FIGS. 1 AND 2. TWO METHODS OF WIRING LIFTING MAGNET

B, located about six or eight feet from the end of the boom, and looped down to the magnet, allowing sufficient slack for free movement up and down.

This method is better than the old scheme in many ways; it is almost absolutely safe so far as accidental grounds are concerned and it takes only a few minutes to make connections. All that is necessary when through using the magnet is to disconnect the wire and tie the loose ends up to the boom.

Pittsburgh, Penn. WILLIAM H. STEELE.

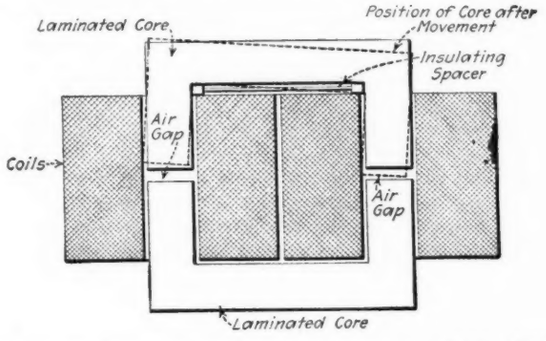
Constant-Current Transformer Failed To Regulate

A constant-current transformer which had recently been installed in a small town to supply a series-tungsten system of street lighting was the cause of considerable trouble and annoyance. The transformer operated on a constant-potential primary circuit and had no moving parts, regulation being effected by a smaller transformer mounted above the main transformer and having a split core, as shown on the diagram. The transformer had been in operation but a short time when the lights on the circuit which it fed began to flicker and grow dim, until the filament barely glowed.

Upon testing, it was found that the secondary current had fallen from its normal value of 6.6 amp. to

4.5 amp. All connections were carefully gone over and checked and were found to be correct. The transformer coils were next taken out of their case, and the normal primary voltage of 2400 volts was applied. Upon the application of voltage a slight movement of the upper core of the regulating transformer was noticed. When the circuit was again broken the core returned to its original position. The regulating transformer was then taken apart and it was found that one of the air gaps was completely closed, thereby decreasing the reluctance of the magnetic circuit and causing the faulty regulation.

No provision had been made for keeping the cores of the regulating transformer apart, except that a small piece of insulating material had been placed between the coils and the upper core. Constant vibration of the core laminations, combined with temperature changes



ARRANGEMENT OF COILS AND CORE IN REGULATING TRANSFORMER

and the natural attraction between the cores while in operation had caused the upper core to sink into the insulation and thereby shorten the air gap. Since the transformer depended upon a constant air gap for its current regulation it was evident that the secondary current would decrease as the air gap was shortened.

In order to overcome the trouble, fiber strips of the same dimensions as the core section and of proper thickness were placed between the cores, and then the two cores were clamped together. This construction did not permit of movement in any direction, and after a few adjustments of the fiber strips had been made the transformer was put into operation and no further trouble was experienced. F. H. OBERSCHMIDT.

Milwaukee, Wis.

Method of Banking Fires

The method of banking fires to be followed depends upon the local conditions and the object sought. In making tests for the purpose of comparing various methods it is understood that all connections are to be tight—no water lost, no steam allowed to escape or to enter the boiler from the header. The setting should be air-tight and the damper shut tight so that no air will be drawn through the boiler setting.

Under these conditions I have found that boilers of 150 hp. can be held in reserve with a fairly good bank on the dead plate, with 918 lb. of good coal (13,500 B.t.u.) per 24 hours. This figure is the average of a series of tests conducted during a period of about three months.

The flat bank referred to by a recent correspondent of *Power* as the best method required from 1400 to 1700 lb. of coal per 24 hours and is not at all satisfactory where volatile bituminous coals are used. Banking at the back end of the grates was found to be neither economical nor efficient from a service viewpoint, as the fire would often appear misleading or go out altogether. As it is natural for a fire to burn from the front back, I consider the front bank the best where the boiler must pick up a load quickly.

Where a boiler is on bank continuously, I have found it advisable to cover a large portion of the grate surface with baffle tile or firebrick, maintaining the bank on one side only.

Various expedients can be utilized in many power plants to reduce the cost of banking fires. Some of them are as follows:

Trap the condensate from the steam headers into idle boilers or boilers on bank. Use boilers on bank to operate condenser auxiliaries, steam exciter, etc.

Bleed steam from the header through a reducing valve into the boilers on bank. This will save considerable coal for banking where it is necessary that a given steam pressure be maintained at all times. This plan works out nicely with the second plan when the auxiliaries are operated from boilers on bank during peak load only.

Cover the grates with kindling, placing a strip of oily waste across the front of the grates. Allow hot water from the feed line to leak into the boiler at such times as a surplus of exhaust steam may exist. Blow down occasionally to maintain the proper water level in the gage glass.

Install live-steam heater coils in the drums of boilers having fires kindled ready to light. Install turbo-blowers on all boilers for the purpose of increasing the capacity. This will usually make it unnecessary to bank boilers for peak loads. Personally, I prefer this plan in conjunction with such other methods as the local conditions will permit or make necessary.

Bypass a portion of the feed water through such boilers as may be needed quickly, the surplus being returned to the feed-water heater. This is an excellent plan where plenty of exhaust steam is available. This plan can be worked out by running the feed pump at a speed that will supply a little more than the normal quantity of water evaporated by the boilers, the surplus being bypassed into the idle boilers. When the water gets too high in the gage-glass of the boilers fired, the pump is not slowed down, but of course judgment must be exercised in opening the valve to the idle boilers or else the feed pump will be speeded up to such an extent that the heater will be pumped dry or else the pump will run away or overspeed.

A good way to overcome this difficulty is to install either a relief valve for this purpose or a small-sized valve piped around the feed valve. The relief valve should also be piped around the regular feed valve with a globe valve in the bypass for shutting off when boiler is in operation.

Fuel oil and natural gas have been used to steam boilers up quickly. This should prove a profitable investment where the load is erratic or variable or in plants where such elaboration would be justified.

Forethought and study along this line have been responsible in great part in producing a better and cheaper service than that offered by the central station. WALDO WEAVER.

Franklin, Ohio.

Live Versus Exhaust Steam for Heating

On page 988 of the June 24 issue of *Power*, James E. Noble discusses the important subject of "Live Versus Exhaust Steam for Heating." This particular subject has been picked to pieces many times, and usually the representatives of central stations have tried to convince manufacturers, hotel owners, etc., that theirs is the cheaper method of obtaining power as compared with that of operating one's own plant. Wherever a goodly percentage of the exhaust steam may be used for heating, for washing or manufacturing purposes, it is considerably cheaper to generate one's own power and utilize the exhaust. Many good plants have been thrown out because the owners listened to the talk and swallowed the figures presented by the central-station men without giving their own engineer a chance to represent his side of the question on equal grounds with the other fellow; and later these same plant owners have found they were buying from 50 to 90 per cent. as much fuel as before and paying a good round figure for current besides. The funny part of it is that few if any of these people have ever admitted the fact or have gone back to what they realize was the cheaper method.

But there looms up another side of the question which is really the most serious part of it. There is one reason, of more weight than all the rest, which gives the glib-tongued central-station agent the advantage, and that is *ignorance* on the part of the engineer, when he does not know how to operate a plant to the best advantage; and the worst and the most discouraging of all is ignorance of the plant owner of the real interest a good engineer takes in his plant, and of not knowing the merits of a really economical proposition when it is put up to him by his engineer. The stubbornness that these men display is due to ignorance.

Let us consider for example, textile mills, where practically all the exhaust may be used for bleaching and dyeing and for heating water for various purposes, and also in the colder months for heating the mill. In such cases it would be decidedly foolish to discard a half-decent power plant and use live steam for all these purposes.

The plant I am operating became overloaded a few years ago and a few small motors were installed to help out. When I came here I showed them a friction load of 246 hp., the entire load carried by the engine being 565 hp. They saw the light, and the first thing done was to have the shafting aligned, which saved nearly 40 hp. on the friction load, and now they are going to install a large alternating-current generator and practically motorize the factory, which will cut out from 60 to 75 per cent. of the remaining friction load and the belts which will be taken out will go a long way toward paying for the motors.

How much better it would be if manufacturers would let their engineers do some of their thinking for them regarding the power question, and do the same thing that we are doing here rather than to trust everything to people who have power to sell. No doubt, in nine cases out of ten, if the amount of money expended in changing a mill over purchased power was used to put in shape the plant which they already have, it would return more than double the interest on the investment; and where, as I have stated, there is plenty of use for the exhaust steam there is no reasonable argument in favor of purchased power.

I have proved to my own satisfaction, by actual test in a plant I was operating, that our coal consumption was only 10 per cent. greater when we were running the engine and using exhaust steam than when we had plenty of water power and were using live steam at reduced pressure.

Every practical engineer must know the advantage of using reducing valves for every purpose where it is possible, therefore it does not seem necessary to consider the use of direct live steam, for the cases are few where it is necessary or advisable. As to using live steam at reduced pressure where the exhaust is insufficient, it is quite true that there are many places where this is done to good advantage, and there are still many places where either or both may be substituted for direct live steam at a great saving by the proper installation of pipe of sufficient size to convey the increased volume of steam at the lower pressure.

I am positive that in a plant where conditions were anything like normal, one could not expect to use as little fuel while using exhaust steam for heating as when using live steam, even when the supply is just adequate to maintain the desired pressure on the heating system. It is evident to me that the difference in the temperature of the live steam, when used in the system, and that of the exhaust would be the basis upon which to calculate the extra amount of fuel to be used while using the exhaust if the same number of heat units are to be given off from the heating coils at a given pressure.

L. M. REED.

Webster, Mass.

Are Operating Engineers Consulted?

How is it that manufacturing concerns, etc., when planning on building a power plant, always go to an architect and a consulting engineer regarding the design of the building and the selection of the apparatus, but never ask an operating engineer into the conference, although he has had a vast experience in practical operation?

After the plant is completed, the engineer is hired and is expected to maint in and keep in operation what they have put in. Is it not a fact, however, that no sooner does the operating engineer assume charge than he finds that there are blunders, some of which cannot be overcome without remodeling the plant, and which might have been avoided had an operating man been consulted?

What do operating engineers think of this subject?

Minneapolis, Minn. L. M. BRATEN.

Girth Seams in Return-Tubular Boiler

Several letters have recently appeared in *Power* stating that trouble in return-tubular boilers having one-piece fire sheets is due to the absence of the supporting action of the circumferential seams. These girth seams were assumed to act as hoops on the boiler and give it additional strength.

I do not agree with this contention. A boiler would be so badly distorted as to be useless before the restraining effect of the girth seams would come into action. When a boiler explodes, it usually gives way at some point where grooving or corrosion has weakened the plate. In such a case the hoop action of the girth seams would be of no value.

D. F. GRAHAME.

Ottawa, Ont., Canada.

Peculiar Pump Test Results

Much has been written about the design and characteristics of centrifugal pumps, and yet, while testing, problems manifest themselves that cause observers to sit up and take notice. During the last year I have tested over fifty pumps in the plants of various manufacturers throughout the East, one of which led to interesting observations.

The 10-in. pump to be tested was to operate at 865 r.p.m., at a 25-ft. head and to deliver 2400 gal. per min. There was no discharge nozzle sufficiently large to accommodate the capacity of the pump, and consequently the head could not be brought low enough to come within the requirements. The friction in the pump, valves and piping consumed the major portion of the head.

It was then suggested that a Y-connection be used, a manometer or gage inserted at each discharge nozzle and the readings combined as though water was delivered from two pumps. As there was no such Y at the

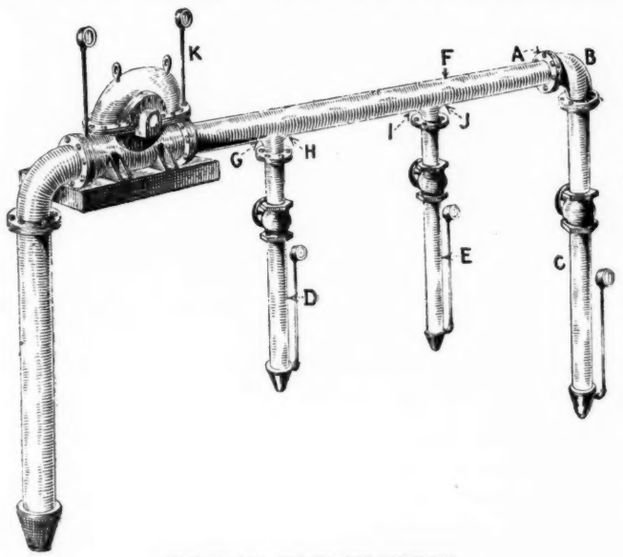


DIAGRAM OF PUMP PIPING

plant and since the pump was urgently needed, it was decided to utilize a manifold that had been procured for some other purpose. This manifold was set up as shown in the illustration, and blanked off at point *A*. Elbow *B* and pipe *C* were not used at this time. When the water was delivered through the pipes and nozzles *D* and *E*, the readings of the gages were combined to give the total gallons per minute delivered, but to our surprise the readings of the head vs. capacity, calculated, gave an increase of head with an increase of capacity, as per the following data:

Head	G.P.M.	Head	G.P.M.
29.23	0	26.2	2080
22.65	2570	22.0	2629
23.60	2550	22.4	2885
25.85	2880	22.65	2995

Since no well-behaved pump should go on such a rampage, it was up to us to determine how it got that way, and this is our solution:

One portion of the water discharged through pipe and nozzle *D* and the other portion of the water that finally discharged through valve and nozzle *E* was first split up into two parts—one part to discharge direct through the pipe and nozzle *E* and the other part to impinge against the blank flange *A*. The mass of water immediately behind that impinging on the flange acts to dislodge the previous impinging water, downward and backward, with a rotary motion, setting up eddy currents from *A* to *F* and then to straighten out in order so that it can be carried through the discharge pipe *E* with the water that discharges in a direct line from the discharge head. Small amounts of eddy current are likewise set up at the points *G*, *H*, *I* and *J* in the manifold.

As the valves of *D* and *E* are opened to admit more water, the pump being run at constant speed, the mass of water impinging upon the blank flange is increased, thereby increasing the force of the impact as well as the eddy currents wherever formed. As this impact increases, it requires more power to overcome it (*AF* equals *dMA*) and consequently the readings of the pressure gage at the discharge side *K* of the pump will register increase with the increase of capacity, or in other words, set up pressure readings that are required not only to deliver the water, but also to overcome the impact and the eddy currents.

It was decided to remove the pipe and nozzle *E*, blank off the opening to *E* and discharge through the pipe and nozzle *D* and elbow *B* and nozzle *C*. This eliminated our trouble and with slight corrections for eddy currents completed a satisfactory test.

New York City. S. ROSENBERG.

Superheated Steam for Reciprocating Engines

In regard to superheated steam for reciprocating engines, we may safely say that there is no one at all versed in steam engineering, who is not ready to admit that from a purely theoretical standpoint superheat is of great benefit in a reciprocating engine and that it is of even greater advantage in this class of prime mover than in turbines. It is, however, when we turn from theoretical considerations and enter the field of practical operation, that we sometimes come face to face with problems and conditions that often make it hard to decide whether superheat is of any advantage in that particular plant.

It is my opinion that with the right cylinder oil a total steam temperature up to but not exceeding 500 deg. F. should not give any lubricating trouble. But sometimes things go wrong, especially in plants where it is necessary to employ chemical reagents to soften the feed water. Here the concentration in the boilers may get too high, the water may accidentally get high, or the safety valve may blow. Any one of these conditions is liable to start priming, and when this takes place the water carried over in the superheater is evaporated, leaving the soda and sediment it contained in the form of a dry, inpalpable powder which the steam picks up and carries over into the engine, thus destroying lubrication and setting up an abrasive action which quickly wears out the piston rings and the cylinders.

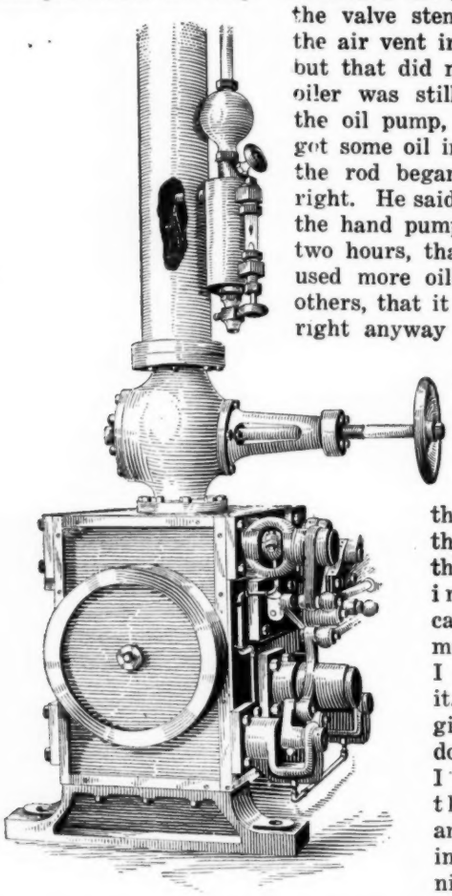
It has been my experience that this excessive wear in the high-pressure cylinder has been the one great drawback to using superheated steam in reciprocating engines in power plants in which there is no surface condenser.

The obvious remedy would seem to be to install surface condensers in all plants using superheated steam. CHARLES L. ANDERSEN.

East Chicago, Ind.

Changed the Lubricator Piping

When a drop of oil disappears up the sight glass of a lubricator, it does not indicate that the oil goes where it is needed, and the engineer must decide by the running of the engine as to whether it is being properly lubricated or not. I once took a night job where a 50-hp. engine ran a steam laundry. The engine was installed in a room separate from the main engine room, and no one bothered much with it so long as it ran. The first night one of the laundry hands complained about the power. The oiler ran to the laundry engine and started to use the hand oil-force pump. The crank-end dashpot would not drop. I loosened the gland nuts on the valve stem and opened the air vent in the dashpot, but that did no good. The oiler was still working on the oil pump, and after he got some oil in the cylinder the rod began to drop all right. He said he had to use the hand pump about every two hours, that this engine used more oil than all the others, that it never worked right anyway and that the piston-rod packing had to be renewed frequently.



CHANGED LUBRICATOR OUTLET

I reported to the chief the next night that I thought the trouble was in the lubricator. He told me to see what I could do with it. After the engine was shut down that night, I disconnected the lubricator and upon screwing out the ½-in. nipple in the steam pipe where the oil entered above the throttle valve, I found only two threads holding it in place. Of course the oil was running down on the inside of the pipe and not mixing with the steam, so that the head-end of the cylinder was getting practically all the oil and the crank end none. I got a bushing, reduced it from ½ to ¼ in. and screwed a ¼-in. nipple through it long enough to reach to the center of the inside of the pipe above the throttle valve so that the oil could always mix with the steam going to the cylinder.

The lubricator was connected and the packing on the piston rod renewed. The engine then ran all right and it was not necessary to use the force pump. The piston rod was turned true, the packing renewed on the four valve stems and the trouble was ended. The lubricator connections on the other engines were also changed.

New York City. PATRICK MALLOY.

Boiler Tubes Burned Out

The following recounts the particulars of the burning out of tubes under the drum and on the opposite side from which the feed water enters the boiler.

The boiler has three drums, 14 tubes high, 21 wide and is rated at 600 hp. We recently installed six boilers of this type and experienced a great deal of trouble with burning out of the tubes connecting with No. 3 drum.

When I called on our chief chemist to look at the condition of No. 3 boiler, in which six tubes were being renewed, he requested a sample of water from each drum while the boiler was running. I suggested that we drill and tap in a ¼-in. pipe in the bottom of the header, directly under the middle of each drum. This was carried out by tapping the header caps opposite the bottom row of tubes and carrying the pipes out through the front doors so that samples could be taken while the boiler was in operation. The caps tapped were Nos. 4, 11 and 18 on the bottom row. The sample thus obtained gave us the exact condition of the water at the point of trouble.

The boiler was filled with water with a salinity of 6 in 100,000 parts, put under pressure and cut in on the line. After it had been in service for 22 hours, a salinity test was made. Another one was made after 41 hours' run. The combined results appear in the following table:

SALINITY, PARTS PER 100,000

	After 22 Hours' Run	After 41 Hours' Run
Under drum No. 1 *	19.0	21.0
Under drum No. 2	22.5	44.5
Under drum No. 3	110.0	170.0

* Drum No. 1 is the one nearest the feed-water regulating valve.

As can be readily seen, the condition in No. 1 drum, as regards salinity, changed but little between tests. In No. 2 the amount of the first test is doubled in the second. The reason No. 3 drum did not increase between tests as did No. 2 was because it was blown twice to the others' once. Up to this time we had blown all three at the same time.

This test shows that the largest portion of the feed water entered No. 1 drum. The rest went to drum No. 2, and No. 3 got its supply entirely from the mud drum, as indicated by the concentration of salt and the extreme cloudiness of the water which was taken from it.

Since then I have made daily salinity tests on each drum of No. 3 B. & W. boiler.

By setting the check valve on No. 1 drum at ¼ turn open, No. 2 at ¾ turn open, and No. 3 wide open, the feed-water distribution has been nearly equal through the whole boiler. This was not done at one step; I went very slowly, first setting the valve on No. 1 drum only at two turns open and so on until they were set as stated. I raised the feed pressure for safety, but otherwise had no trouble keeping water in the boiler, even when it was running at 60 per cent. overload.

No tubes have been lost since the test pipes were put on this boiler, so I am putting test pipes on all the boilers as soon as they are down. The builders are working on a different feed-pipe arrangement that will insure equal feed-water distribution.

I should like to hear from someone else through the columns of *Power* on tube troubles and their prevention.

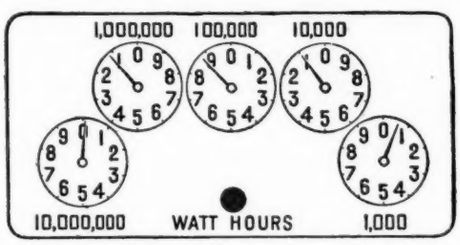
Crockett, Calif. C. A. NELSON.

What Does the Meter Read?

The dials of A. A. Frederick's watt-hour meter, reproduced here from the Sept. 2 issue of *Power*, are indeed suffering a bad case of misplaced pointers. This is the cause of many errors being made, even by the most experienced of meter readers, and therefore great care should be exercised in reading such meters, and the results should always be checked.

Misplacing of the pointers is the result of two causes, one of which is that there is always a certain amount of backlash or slack in the gears of the recording train, which, when it is taken up by the rotation of the gears, which progresses from right to left, the gear ratio usually being 10 to 1, causes the pointer to the left to lag, or read behind the figure which it should indicate. The other cause is the actual misplacing of the pointer on the shaft, in which case the pointer may be behind or ahead of its proper position.

To read this meter correctly and to be sure the reading is right, the record of previous readings should be available to be used as a check. The two lowest-reading dials seem to be in about their proper position with respect to each other. Therefore, the 1000 dial may be read as 0, and since the pointer of this dial is to the right of 0, the next dial to the left will be read as 1,



WATT-HOUR METER DIALS

making the reading so far 10, or equal to one complete revolution of the lowest reading dial, or 1000 watt-hours. Coming to the third, or 100,000, dial we get to the place where our previous records become very valuable in assisting to read correctly. Since the second lowest dial pointer is on 1, we know that the third dial pointer should register very close to one of the numbers, and as it is nearest to 9, it may safely be assumed that, owing to excessive slack in the gears or a combination of the two causes of this trouble that 9 is the correct figure, making the reading now 910. The fourth dial has passed 1, but as the third dial has not as yet made a complete revolution it is evident this dial should still be read as 0. This conclusion is strengthened by the position of the fifth dial, which has moved but slightly to the right of 0 and not enough to indicate that the fourth dial should be near the 2, which position it must be in to be read as 1, considering the position of the third, or 100,000, dial.

Assuming the foregoing conclusions to be correct, this meter should be read 0,091,000 watt-hours, or if it is desired to split the divisions of the lowest reading dial, 0,091,060 approximately, GEORGE E. LYONS.

Woodhaven, N. Y.

Referring to "What Does the Meter Read," in the Sept. 2 issue of *Power*, I would give the following solution:

The 1,000 hand has not reached 1, so I would put the reading of this dial at 0. The 1000 hand having passed 0 would indicate that the 10,000 hand has just passed a number, and as this hand points nearly to one, the reading of this dial would be 1. The 10,000 hand reading 1 would indicate that the 100,000 hand should be slightly by some number. The hand points nearest to 9, so I would put the reading of this dial as 9. The fact that the 100,000 dial reads 9 would indicate that the hand on the 1,000,000 dial should be very nearly to but has not yet reached some number. This hand points a little beyond 1, but should not have reached 1 yet. This dial should then be read 0. The 1,000,000 dial reading less than 1 would indicate that the 10,000,000 hand should be just by some number. As this hand points slightly by 0, this dial reading is taken as 0.

My interpretation of this meter reading is 0091000 or 91,000 watt-hours. It is apparent that the hands on the 100,000 and 1,000,000 dials are misplaced and should be corrected, as it would be very misleading to a meter reader to have them as shown.

Montour Falls, N. Y. FRANK L. SCHLICK.

Following the rule for meter reading, the solution of "What Does the Meter Read?" *Power*, Sept. 2, is quite simple.

Since the first, or right-hand, dial has made a complete revolution, the second dial will be at a figure, in this case, 1, and since the second dial had just completed a revolution and passed to the first figure, the third or center dial must be at 9 regardless of the position of the hand. The third hand has not completed the revolution, therefore, the fourth dial must still be read 0, the fifth or left-hand dial is still at 0, so the complete correct reading is 91,000 watt-hours.

In reading dials like this all that is necessary is to remember that the first, or right-hand, dial is fixed to the metering mechanism so must be correct, and that if there is backlash in the gears the other will drop to the lower side of the proper position to the limit of the backlash. ALLAN A. BLANCHARD,

Chief Engineer, Ringwood Co.

Ringwood Manor, N. J.

I notice in the Sept. 2 issue of *Power* a meter dial to be read. It is evident that there is a hand displacement on this meter. Lettering the dials *A*, *B*, *C*, *D* and *E*, *A* being the extreme left-hand dial and *E* the right-hand dial, dial *E* would be read 0, dial *D* 1, dial *C* should be slightly past some index number, where now it is two-thirds distance between 8 and 9. Dial *B* is also misplaced. Hand *B* should have traveled nine-tenths the distance between 0 and 1. If I were to read this meter in regular routine work, I would consider this reading 91,000 watt-hours and then consult previous readings to make sure I had the hand displacement properly accounted for.

Mechanics Falls, Me. ALBION C. BARKER.

[The foregoing letters give the correct reading and the method of reading the watt-hour meter dials published in Sept. 2 issue of *Power*. Other answers were submitted by L. W. Wyss, 91,060; Leon L. Pollard, 91,000; Earl Pagett, 91,075; George Leverance, 91,000; Frank Wenger, 1,910,000; Henry Mulford, 121,000; E. A. Quinter, 181,070; C. M. Hamann, 0,091,100; H. G. Brinckerhoff, 01,810; George B. Lampkin, 1,910,000; D. G. Simmons, 01,010; W. F. Condon, 1,810,000; Geo. H. Boren, 91,000. It is regretted that space would not permit publishing the solutions of all those sending in correct answers.—Editor.]

Installation and Use of Air Chambers

In *Power* for Aug. 5, 1919, page 209, is an article on the "Installation and Use of Air Chambers," by H. D. Fisher; also the July 8, 1913, issue contained an article on the same subject, entitled "Functions and Design of Air Chambers," by the writer. In recognition of certain important principles and requirements the two articles are in agreement.

It is mutually established that: pulsations in flow in the pipe line cause too high readings in the venturi, orifice and pitot types of meters; the only practical method of overcoming this difficulty from pulsations is to absorb them by means of air chambers; the function of the air chamber is to store up energy during the forward stroke of the feed pump and give it out again when the pump is reversing, thus "smoothing out" the flow; the flow of the water must be artificially directed against the air cushion in the chamber; the air chamber should be fitted with a gage-glass and proper means for charging the chamber with air should be provided.

In addition the earlier article points out that air chambers on reciprocating pumps are often valueless,

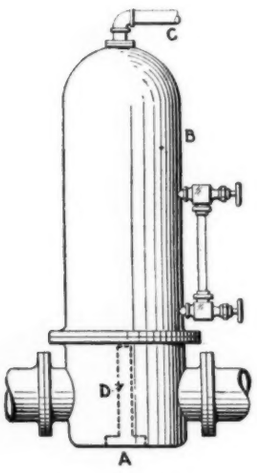


FIG. 1. AIR CHAMBER WITH SPECIAL CASTING

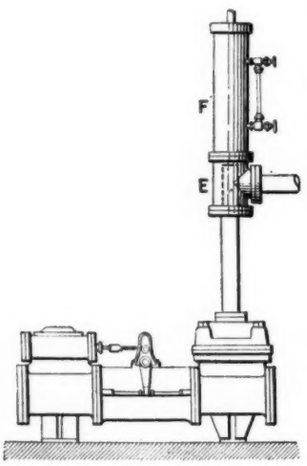


FIG. 2. AIR CHAMBER PLACED ON A TEE

owing to improper design or operation; that in boiler plants, pulsations in flow usually are accompanied by destructive water-hammer on pump parts, boiler-check valves, main valves, gaskets, etc., and that it is highly important to carry a pressure in the feed line in excess of the boiler pressure to enable the air chamber to perform properly its function of absorbing and giving out energy.

The two articles disagree materially in the design of the air chambers. Mr. Fisher claims that best results are obtained by making the air chamber of the same size pipe as the feed line and obtaining the necessary volume by increasing its length and that if it is made either larger or smaller, there will be an abrupt change of velocity in the water entering or leaving the air chamber, with a corresponding loss of energy and efficiency.

In my article two general designs were shown: Quoting from the article:

> If it is absolutely necessary to place the air chamber in the main line, a special casting *A*, Fig. 1, should be made, containing a vertical partition several inches higher than the main pipe connections. On the top of this special casting may be mounted another casting *B*, of the shape illustrated, or if preferred, this top piece can be made up of pipe fittings. A gage-glass should be attached to the lower end of *B*. There should also be a connection *C* of, say, ¼-in. pipe, for charging the air chamber when the gage-glass shows that the air has been partly absorbed. It will be noticed that the course of the water is directed by the baffle *D* against the air space, and then has to change its direction again before leaving the chamber.

It is usually possible, however, to locate the air chamber on a tee, as illustrated in Fig. 2. This is a less expensive and fully as effective arrangement. All the fittings may be made up from stock pipe and specials. It is essential that the discharge pipe from the pump be carried above the outlet from the tee, as shown at *E*, so that none of the water can pass the tee without coming in contact with the air space in chamber *F*. This bypassing materially reduces the effectiveness of the air chamber.

In both illustrations it will be noted that the air chambers are made considerably larger than the feed line, and the following dimensions were recommended:

Size of Discharge Line, In.	Inside Diameter of Air Chamber, In.	Total Height of Air Chamber Ft.
2	8	2
2½	8	2½
3	10	3
4	10	4
5	12	5
6	16	6

Accompanying this table is this explanation:

With the exception of the single-cylinder, single-acting, direct-connected pump, which is not often found in power plants and which is diminishing in favor, the dimensions of the air chamber should be sufficient to provide an air space from five to six times the displacement of one pump plunger. The size of discharge lines bears a fairly constant ratio to pump capacity, and satisfactory results have been obtained from air chambers of the above dimensions.

It will be noticed that the height in feet corresponds to the diameter of the line in inches. If there is not headroom enough, the chamber may be reduced in height and increased in diameter, retaining the same volume and making the neck as large as the second column of the table.

Some eight years of experience with air chambers have thoroughly confirmed the recommendations of the original article. In most instances the proof of the effectiveness of the air chamber has been visibly demonstrated by a mercury manometer attached to a venturi meter tube in the food line. It is regrettable that more data on this important subject have not been published. Numerous readers of *Power* undoubtedly could add valuable comments from their experience, and it is hoped that this discussion will bring out such contributions.

Providence, R. I. CHARLES G. RICHARDSON.

Explosion of Sanitary Process Apparatus

This letter reports an investigation of the explosion of one of the portable sterilizers in the sanitary process plant of an Eastern camp. Each of these sterilizers, which are used to delouse the clothes of soldiers returning from over seas, consists of a vertical boiler designed for 120 lb. pressure and a steam-jacketed sterilizing chamber, all mounted on a truck. A steam ejector is provided to produce a vacuum in the sterilizer. Proper reducing valves, gages, etc., are supplied for regulation and operation. The door of the sterilizer is mounted on crane trunnions and is made tight by means of radial arms which lock into the flanged frame of the chamber body.

The manufacturer's instruction for operation are substantially as follows:

A constant steam pressure of from 45 to 60 lb. is maintained in the steam jacket. After the clothes are placed in the sterilizing chamber, a vacuum of 15 in. of mercury is produced by the ejector to remove as much

air as possible from the clothes. Then steam is admitted until the pressure in the chamber reaches 15 lb. gage. This maximum pressure is controlled by a reducing valve. The steam is then shut off, the pressure relieved through an outlet valve and the vacuum restored. The entire process should not last more than fifteen minutes.

After the explosion an investigation showed that although these units had been in continuous operation for about six months, the boilers, fittings, valves, etc., had never been cleaned or inspected. The try-cocks, gage-glass fittings and blowoff valves were stuck fast with scale. The reducing valves, gages and control valves were also more or less obstructed with scale so that they could not operate properly. The vacuum gage showed a negative reading, while the pressure gage on the jacket read 30 lb. when they were both open to the atmosphere.

The story of the accident appears to be as follows:

On opening the steam valves the operator could not get the desired pressure, and after opening the main valve wide he opened the bypass around the reducing valve. One of two things happened. Either the steam pipe, being plugged with scale, was suddenly cleaned out by the high-pressure steam coming through the bypass, or the pressure had gradually built up owing to the leaky condition of the reducing valve, but did not show on the defective gage. The resulting pressure buckled the door and bent the locking arms so that the door was blown off.

The real cause of the trouble was obviously ignorant and careless operation without proper supervision. As a precaution against future trouble instructions were given requiring strict compliance with the manufacturer's operating instructions, monthly inspection of all parts, fittings, etc., especially reducing valve, and thorough monthly cleaning of the boilers. It was also suggested that steam be supplied from a central boiler plant where proper boilers, vacuum pumps, etc., might be maintained under the care of skilled operators.

New York City. S. ROSENBERG.

"Horrible Examples" in Steam Plants

At one time it was the practice of reform workers when preaching to have a "horrible example" on the platform as a danger sign for their audience. Perhaps some efficiency converts could be made by bringing to the attention of *Power* readers some of the "horrible examples" in steam plants, of which there are many.

Awhile ago I assumed the responsibility of the maintenance and operation of one of these "horrible examples." This plant has six boilers with a total of 1840 hp. Nos. 1, 2 and 3 boilers are served by a 7-ft. diameter, 130-ft. high steel stack. The weight of this stack and heavy ⅜-in. steel breeching is borne by the settings of Nos. 1 and 2 boilers. Each of the other settings support a single stack and breeching. On account of the swaying of the stacks, it is impossible to keep the boiler settings tight—in fact, it is difficult to keep them from collapsing.

The coal burned is 30 per cent. volatile matter and averages about 13,500 B.t.u. It is hand-fired in furnaces where the ratio of combustion space in cubic feet to square feet of grate surface is not more than 2½ to 1, and it is burned at the rate of 25 lb. per square foot of grate surface per hour. Nos. 1 and 2 boilers have but 39 sq.ft. of heating surface to each square foot of grate surface, and the stack temperatures approach 800 deg. F. All dampers are kept wide open for all loads and for no-load conditions. The condition of the furnace fronts is such that the fireman examines his fire, and might also coal up, without opening the fire-doors.

A steam header 75 ft. long is supported on iron posts along the boiler fronts with each boiler connection made with a valve and straight nipple. From the center of the boiler flange to the center of the header is but 52 in., with no provision for changes of expansion of the header. Of course the joints all leak, and I wonder that some have not torn loose. The steam lines are excessively large, with much uncovered surface, and all steam traps discharge outdoors.

It was the practice of the firemen when cleaning fires to push the fire back and then turn on the hose and drench the front of the fire. Result, a mason and a helper were kept hustling all the time. We have an open heater that is apparently very dirty, with the holes in the pans sealed over, as it exhausts a considerable quantity of steam when the temperature reaches 150 deg. F.

We expect, however, in less than six months to improve some of these conditions. A new chimney is already erected and the contract made for installing new breechings. An automatically operated main damper and uptake dampers for hand control will be provided. The settings are to be rebuilt and the boilers raised to give greater combustion space. The grate surface will be properly proportioned and new furnace fronts installed. The discharge of steam traps will be recovered and steam leaks and radiation losses eliminated as far as possible. We have on hand new nonreturn stop valves to install in the new connections between the steam header and the boilers.

With the changes mentioned and equipment for weighing coal, metering water, making proximate coal analysis and instruments to indicate and record boiler and furnace performance, we are anticipating a large increase in plant efficiency.

The nonreturn stop valves for these boilers were on the premises when I took charge and were ordered to conform in size to the boiler flanges, which are all 8-in. extra-heavy pattern. One boiler is of 480 hp. capacity, one 364, one 316, one 240 hp. and two are 220 hp. each. Steam pressure is carried at about 150 lb. gage.

As a nonreturn valve gives a longer and more satisfactory service with a velocity of steam flow above 5000 ft. per min., I wrote the manufacturer of the valves explaining that the steam velocity through these valves on the smaller boilers would be less than 1100 ft. per min. They agreed with me and are arranging to exchange the valves for smaller ones and credit us with the difference in price, which is more than 50 per cent. of the original bill. The valves we have decided on are smaller than good practice might seem to indicate.

A discussion by *Power* readers on the advantages of high steam velocities and the limit for good practice for different classes of work should prove of interest to many.

Our boiler-feed line is, I think, also too small, which requires a pressure at the pump considerably in excess of the boiler pressure.

For feeding 60,000 lb. of water per hour at 212 deg. F., what size of pipe is required? DAVID CRAFT.

Auburn, N. Y.

B. T. U.'s No. 1 of the N. A. S. E.

What are the B. T. U.'s of the N. A. S. E.?

They are the best friends of that organization, their main object being to induce N. A. S. E. members to attend and take active part in their meetings, to help reorganize weak associations that have dropped out or are liable to drop out of the state association. They are not, however, to interfere in any way with the N. A. S. E., but will encourage its members to be known at their meetings. The emblem is shown herewith.

THE EMBLEM

The B. T. U.'s will make their meetings attractive and interesting by having drills with the degree that will impress the candidate as to his obligation, also there will be uniformed drills for street parades. They will try to make the N. A. S. E. better known in the business world.

There is only one B. T. U.'s association in the country, and it is in its infancy, but it promises big returns. They invite any and all N. A. S. E. associations to inquire of Earl C. Olin, 490 Court St., Rochester, N. Y., for details and information, regarding its mission.

Rochester, N. Y. EARL C. OLIN.

Slow Engine Speed and Condensation

Referring to the discussion (*Power*, July 15, page 116; Aug. 19, page 311) regarding slow engine speed and condensation, I am thoroughly convinced that every power plant has to have a different set of rules to work by and that the system and arrangement of installing and operating machinery that will work well in one plant will be a failure in another. The circumstances surrounding the case is the vital point, and the obstacles, such as they are, have got to be overcome. The method employed may not be exactly correct from a mechanical point of view, but possibly no other arrangement would meet the necessary requirements, therefore we have to attack the difficulties in the way that is most suitable for the trouble in question.

Going back to the question of mechanical stokers driven by steam engines, which means a varying speed according to the power consumed, there is a normal speed for these engines to run, although there are times when the speed is either far above or below it, and occasionally for a short interval a complete stop, then a sudden start up at, for instance, the normal speed, and then the engine gets a dose of water which causes all kinds of trouble.

Steam traps and separators are fine things and save thousands of dollars annually in various ways, but in the case of steam pipes which convey steam to stoker engines, etc., I think that they are unnecessary. Such engines are usually installed on the boiler front or setting, and it is simple and easy to allow a 6-in. or a 1-ft. fall in the steam line from the boiler to the engine, the low end being at the boiler. If the engine is stopped for five minutes or even one hour, most of the condensed water from the steam, as fast as it accumulates, is gradually draining back into the boiler or heater, thereby obviating the necessity of mechanical devices.

H. W. ROSE.

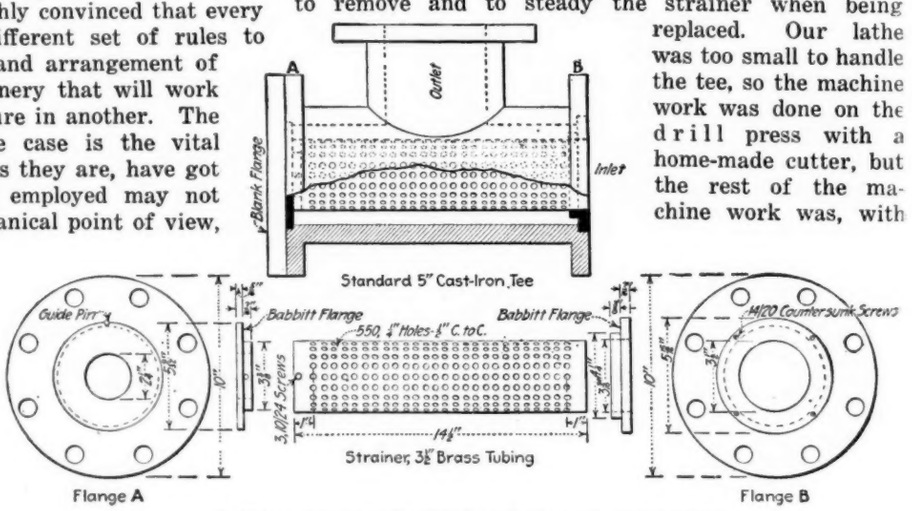
Brenham, Tex.

Homemade Pump-Line Strainer

The strainer, made as illustrated, was placed in the water supply line for a turbine air pump serving a 2500-kw. turbine. The original strainer (which was left in the line) consists of two baskets, which are lifted out of the strainer body when cleaned.

One day we lost the vacuum on account of trouble with the air pump. This was found to be caused by a cinder lodging in one of the nozzles of the pump. We concluded that in some manner the cinder had dropped out of the basket while being cleaned, and in that way entered the pump. To avoid future trouble along the same lines we made and installed a strainer of our own close to the pump, and between the pump and the other strainer.

The supply line is 4 in. A 5-in. flange was bored out to fit the 4-in. pipe and to which the flange *B* of the tee was bolted. The outlet flange was fixed in the same manner. The hole in the babbitt flange fastened into the flange *B*, is tapered so as to make it easy to insert the strainer. The babbitt flange in flange *A* is fastened to the strainer by means of three machine screws, and has a hole in it to make it easy to remove and to steady the strainer when being replaced. Our lathe was too small to handle the tee, so the machine work was done on the drill press with a home-made cutter, but the rest of the machine work was, with the exception of drilling of the holes, done on the lathe.



DETAIL OF HOME-MADE PUMP-LINE STRAINER

W. H. MOORE.

Paterson, N. J.

In every boiler room there should be one man to supervise the work of the others. His duty is to see that the necessary coal is delivered to the stokers, that the water level is properly maintained in the boilers, that each man does his fair share of work, and to instruct them how to obtain the most from the fuel fed to the furnace.

INQUIRIES OF GENERAL INTEREST

Hydrostatic Test Pressure for Boiler—If a boiler safety valve is to be set to blow at 250 lb. gage pressure, what should be the hydrostatic test pressure? F. S.

A boiler should be subjected to a hydrostatic test of one and one-half times the maximum allowable working pressure, and the test pressure should be under proper control so that the required test pressure should not be exceeded by more than 6 per cent. If the safety valve is to be set to blow at 250 lb., the boiler should be subjected to a hydrostatic test of $1\frac{1}{2} \times 250 = 375$ lb. per square inch.

Critical Speed of Shaft—What is meant by the critical speed of a shaft? R. E. B.

The critical speed is that speed of rotation at which the elastic forces are completely neutralized so that the shaft is incapable of offering any resistance to a deflecting force. This speed is numerically the same as the frequency of vibration that the shaft would have with the same masses mounted on it, if deflected by an external force, while the shaft otherwise is at rest. The axis of rotation rarely passes through the center of gravity, and the "hammering" due to centrifugal deflection is greatest when the r.p.m. are in unison with the number of vibrations.

Use of Glycerin for Hydrostatic Tests—Why is glycerin used in place of water in making hydrostatic tests of castings or forgings that are for high-pressure service, such as recoil cylinders of cannons? E. E. R.

Pine glycerin is rarely if ever used for the purpose, but it mixes readily with water and the viscosity of the mixture renders it easier to hold under high pressures against leakage of joints and packing. Other advantages are that the mixture is much less corrosive of metals than water and the freezing temperature of the mixture is lower than that of water, a 5 per cent. glycerin solution in water having its freezing point at about 10 deg. above, and a 10 per cent. solution at about 10 deg. below zero.

Rotation Direction of Alternator—Does it make any difference which direction a newly installed alternator revolves? Or will the exciter connections to the alternator have to be reversed in case the generator is rotated in a direction opposite from that intended by the manufacturer? The exciter is driven from the alternator. E. G. H.

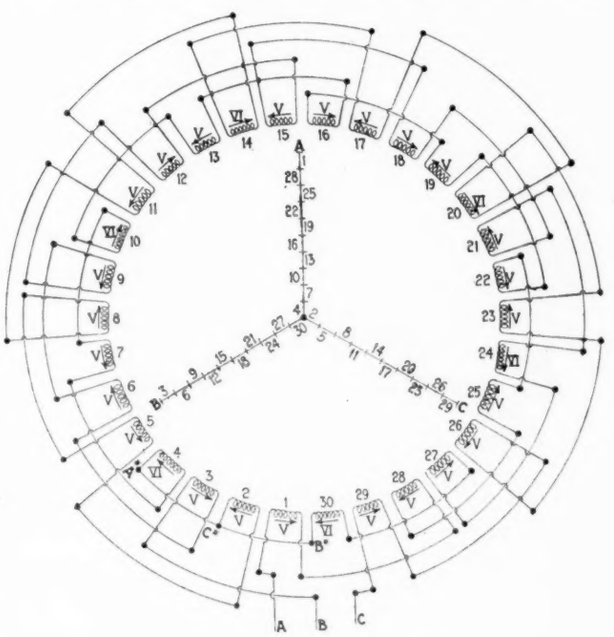
If the machine is operated as a single unit, it will not make any difference in which direction the rotor revolves. If the direction of the exciter is reversed, it will be necessary to cross either its armature or field leads so that the machine will generate. Where the alternator is operated in parallel with other machines care will have to be taken to see that the new machine has the proper phase relation to the bus voltage.

Omission of Counterbores from Duplex Pumps—Why are not the cylinders of a duplex pump counterbored? S. O. R.

The cylinder of a reciprocating engine that is constrained to a uniform length of stroke is counterbored so the piston may override the ends of the main bore and thus prevent the wear from forming shoulders in the bore at each end of the stroke. With a duplex steam pump the absolute length of stroke and portion of the cylinder over which the pistons travel vary with speed, steam pressure, valve setting and chance amount of "lost motion" of the valve gear; there is little likelihood of formation of abrupt shoulders from wear and, for ordinary duplex pumps, there is little or no advantage in counterboring the cylinders.

Uneven Number of Coils in Rotor Phases—In a 40-hp. three-phase wound-rotor motor in which I short-circuited the slip ring and tried starting with a 50-hp. compensator, the motor developed positions where it would not start; in fact, the operation of the motor was so unsatisfactory that operating it under the foregoing conditions was abandoned. The stator has 120 coils grouped in a 10-pole winding, and the rotor has 156 coils connected two phases of 57 coils each and one phase of 42 coils, connected series star. Why is it that there is not $156 \div 3 = 52$ coils in each phase? Has the unbalancing of the winding anything to do with the trouble that the motor developed? M. P.

It is apparent that a mistake has been made in connecting up the windings; two pole-phase groups of 5 coils each being



THREE-PHASE SERIES-STAR GROUPING

taken out of the phase that has only 42 coils and connected into the two phases that have 57 coils each.

With 156 coils, in a 10-pole rotor, to give a balanced winding there will be 52 coils per phase, grouped 8 poles of 5 coils each, and 2 poles of 6 coils each; the 6-coil pole-phase groups will have to be distributed as in the figure. The Roman notations indicate the number of coils in each pole-phase group.

There is little doubt that the way the rotor was connected contributed to the unsatisfactory operation of the motor, especially at starting. However, after the motor was started it should have given satisfactory service unless there was some trouble in the stator winding or connecting wires.

Semiannual Hearing of Massachusetts Board of Boiler Rules

THE semiannual hearing of the Massachusetts Board of Boiler Rules was held at the State House, Boston, on Thursday, Nov. 6.

The Hartford Steam Boiler Inspection and Insurance Co. asked that the form of certificate be changed so that it could be filled out on the ordinary typewriter. This could be done without changing the size of the certificate or the frame in which it is preserved, by simply turning it through 90 deg. and making its greater dimension in the direction of its length instead of the width. The only change in the wording suggested was that the date or year in which the boiler was put into service should be recorded, instead of the number of years in service, which latter quantity had to be changed every year, whereas the former would remain the same during the life of the certificate.

Dr. Charles L. Huston, of the Lunkens Steel Co., petitioned that Par. 9, Sec. 4, of Part III, be amended as follows:

PRESENT READING	PROPOSED READING
A horizontal return-tubular, vertical-tubular, or locomotive-type boiler shall not have a continuous longitudinal joint over twelve (12) feet in length.	In horizontal return-tubular boilers with lap joints, no course shall be over twelve feet long. With butt and double-strap construction longitudinal joints of any length may be used, provided the tension-test specimens are so cut from the shell plate that their lengthwise direction is parallel to the circumferential seams of the boiler, and the plates meet the standards prescribed in the specifications for boiler-plate steel.

The causes which led to difficulty with the use of large sheets and long seams some years ago, Dr. Huston said, have been largely removed. At one time it was thought that a superior design had been found in a boiler with a single lower sheet, which avoided the circumferential seam over the fire, and looked promising, but several disastrous failures of boilers so constructed occurred. It is now thought that this may have been due to the fact that the sheet was used lengthwise in the boiler—that is, rolled across the grain—and was not wide enough to get the longitudinal seam up out of the furnace, the trouble being due to overheating at the seam. Plates are now obtainable in widths up to 16 ft., so that objection no longer exists. The fact that the greatest tensile strength is at right angles to the direction in which the plate was last passed through the rolls is of little importance, for in the making of these wide plates a great deal of cross-rolling is done. To get the desired width, the billet is turned and put through the rolls sidewise, so that there is drawing of the material in both directions, and not so much tendency to the formation of a grain or fiber as when the rolling is all lengthwise.

S. F. Jeter, chief engineer of the Hartford Steam Boiler Inspection and Insurance Co., said that the shorter course was stronger, but that the longer course seemed to have compensating advantages.

F. R. Low, editor of *Power*, told of the discussion which has been going on in these columns on the subject, and pointed out that while the objection to the long seam appeared to be founded upon failures in practice, none of these failures have apparently occurred with butt-strap joints. In a contribution now in hand, C. E. Stromeyer, chief engineer of the Manchester, England, Steam Users' Association, says that he prefers long seams.

J. O. Leech, secretary of the Association of American Steel Manufacturers, said that plates that have been cross-rolled show little difference in elongation or bending, in whichever direction the test piece is taken, but with plates that were "universal rolled" the crosswise specimens do not show so much elongation, nor bend so well, as those taken lengthwise of the sheet. He removed from Dr. Huston's petition any appearance of self-interest by explaining that a number of other mills besides the Lunkens were furnishing wide plates.

The Massachusetts Rules require that "each boiler shall be stamped by the builder, in the presence of the inspector, with a serial number and with the style of stamping shown in facsimile previously approved by the Board."

It occasionally happens that the representative of the manufacturer picks up the wrong stamp, or in some way stamps the wrong number upon the boiler. In such a case the Board has insisted that the inspector, and in some cases that both the employee who made the mistake and the inspector, come to Massachusetts and make the correction. This seems to involve unnecessary delay and expense, and the Hartford Steam Boiler Inspection and Insurance Co. petitioned the Board to allow the change to be made by one of its own inspectors upon conviction that an error had been committed, and that the boiler upon which the correction was asked to be made was identical with that covered by the certificate in hand.

The Association of American Steel Manufacturers petitioned:

That the sulphur limit for extra-soft steel should be changed from 0.04 to 0.045.

That Par. 6 in Sec. 1 of Part III be modified as follows, so as to carry out the obvious intent of the paragraph, which is that a deduction of 1 shall be made from the percentage, and not a deduction of 1 per cent. from the elongation:

PRESENT READING	PROPOSED READING
(a) For each increase of ⅛ in. in thickness above ¾ of an inch, a deduction of 1 per cent. shall be made from the specified elongation.	(a) For material over ¾ of an inch in thickness a deduction of 1 from the percentage of elongation specified in Sec. 5 shall be made for each increase of ⅛ in. in thickness above ¾ of an inch.
(b) For each decrease of ⅛ in. in thickness below ⅞ in., a deduction of 2½ per cent. shall be made from the specified elongation.	(b) For material under ⅞ of an inch in thickness a deduction of 2½ from the percentage of elongation specified in Sec. 5 shall be made for each decrease of ⅛ of an inch in thickness below ⅞.

That Par. 16 of Sec. 1 of Part III be changed as follows:

PRESENT READING	PROPOSED READING
16. The variation in cross-section of weight of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations:	(a) When ordered to weight per sq. ft. the weight of each lot in each shipment shall not vary from the weight ordered more than the amount given in Table 1.
(e) Plates 12½ lb. per sq. ft. or heavier, up to 100 in. wide, when ordered to weight, shall not average more than 2½ per cent. variation above, or 2½ per cent. below the theoretical weight; when 100 in. wide and over, 5 per cent. above or 5 per cent. below the theoretical weight.	(b) When ordered to thickness, the thickness of each plate shall not vary more than 0.01 in. under that order. The overweight of each lot in each shipment shall not exceed the amount given in Table 2.
(f) Plates under 12½ lb. per sq. ft., when ordered to weight, shall not average a greater variation than the following: Up to 75 in. wide, 2½ per cent. below the theoretical weight; 75 in. wide up to 100 in. wide, 5 per cent. below the theoretical weight; when 100 in. wide and over, 10 per cent. above or 3 per cent. below the theoretical weight.	
(g) For all plates ordered to gage there will be permitted an average excess of weight over that corresponding to the dimensions of the order equal in amount to that specified in the following table:	

While the present specifications provide for variations in weight for plates ordered to weight per square foot, it is customary to order boiler plates to gage only. If it is decided to change the rules in order to provide for gage only, only paragraph marked (*b*), as above, should be used, or the following from the A.S.M.E. Boiler Code could be used:

"The thickness of each plate shall not vary under the gage specified more than 0.01 in. (The overweight limits are considered a matter of contract between the steel manufacturer and the boiler builder.)"

Par. 18, 19 and 20 of Sec. 1 of Part III, dealing with the stamping of plates and heads, should be changed as follows:

PRESENT READING	PROPOSED READING
18. Each plate shall be distinctly stamped by the manufacturer with the heat number.	MARKING. (a) Each shell plate shall be legibly stamped by the manufacturer with the melt or slab number, name of manufacturer, grade, and the minimum tensile strength of the stipulated range, as specified in par. 9, in three places, two of which shall be located at diagonal corners, about 12 in. from the edge, and one about the center of the plate, or at a point selected and designated by the purchaser, so that the stamp shall be plainly visible when the boiler is completed.
19. Each plate shall be distinctly stamped by the manufacturer in at least five places in the following manner: At the four corners, at a distance of about 12 in. from the edges, and at or near the center of the plate, with the name of the manufacturer, place where manufactured, brand and lowest tensile strength.	(b) Each head shall be legibly stamped by the manufacturer in two places, about 12 in. from the edge with the melt or slab number, name of manufacturer, grade, and the minimum tensile strength of the stipulated range, as specified in par. 5, in such manner that the stamp is plainly visible when the boiler is completed.
20. Each head shall be distinctly stamped by the manufacturer on each side with the name of the manufacturer, place where manufactured, brand and lowest tensile strength, stamps to be so located as to be plainly visible when the head is finished.	(c) Each butt strap shall be legibly stamped by the manufacturer in two places, on the center line about 12 in. from the end, with the melt or slab number, name of manufacturer, grade, and the minimum tensile strength at the stipulated range, as specified in par. 5.
	(d) The melt or slab number shall be legibly stamped on each test specimen.

It was claimed that the present Par. 20 had been interpreted by the Board as meaning that the head should be stamped not upon the two faces, but upon two sides, or edges, of the same face, so that the plate would not have to be turned over when the stamping was done. The tables referred to are those adopted by the American Society for Testing Materials. The heat number can always be identified by the slab number.

An informal discussion as to the legibility of stamping, and especially as to some means of locating the stamp marked upon the plate, ensued. Mr. Koopman, of the New England Boiler Works, said that on an average it cost a dollar a plate to find the stamp on a boiler. A legible stamp, easily found, was of great assistance to the boiler manufacturer, and five stamps on a plate made it easier to find one of them than as though there were but three.

Dr. Huston explained the impracticability of turning the plates over to stamp on both sides, and the difficulty of keeping the stamps sharp. The stamps became dull and legibility was reduced when they were obliged to stamp five times upon one sheet, instead of three. It was suggested that the name of the manufacturer might be etched in the rolls, and thus appear in raised letters upon the plate, as is done in the manufacture of pipe, the stamping being placed near one of these marks.

Dr. Huston stated that he had never been able to find any positive testimony that sulphur was detrimental. It is difficult to meet the requirements of the rule with regard to sulphur content when coal is used as a fuel, and the growing scarcity of natural gas makes steel manufacturers anxious about the reduction of the allowable amount of sulphur. Where a sufficient quantity of manganese is present the deleterious effects of sulphur are corrected. If you have 0.30 of manganese, which is the minimum specified, you can take care of 15 points of sulphur. The matter was being worked out by the Bureau of Standards coöperating with producing and consuming interests.

Mr. Scannall, of the Scannall Boiler Works, Lowell, Mass., argued that heads should be stamped upon both sides, that is, upon both faces, and Mr. Koopman, of the New England Boiler Works, explained the difficulties which the boiler manufacturers got into by using ready-flanged heads, some of which had to be stamped on the convex and some on the concave side to make the stamping come on the outside of the boiler as built.

C. M. Flagg & Co., Inc., of Meriden, Conn., petitioned that Par. 68 of Sec. 4 of Part III be amended as follows:

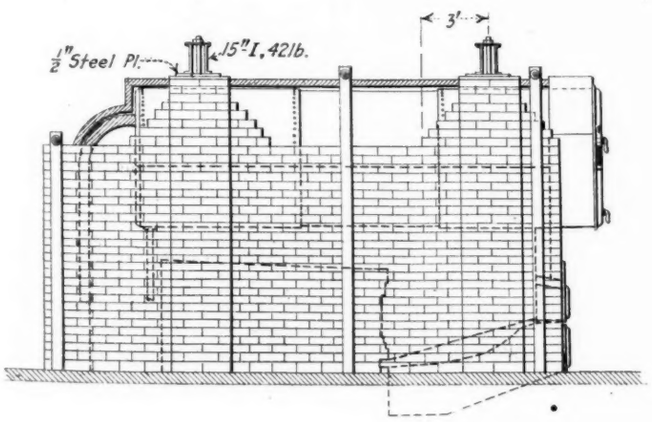
PRESENT READING	PROPOSED READING
68. A horizontal return-tubular boiler over fifty-four (54) inches in diameter, and up to and including seventy-eight (78) inches in diameter, shall be supported by the outside-suspended type of setting, or by not less than four (4) steel or cast iron brackets on each side set inside.	A horizontal return-tubular boiler over fifty-four (54) inches in diameter, and up to and including seventy-eight (78) inches in diameter, shall be supported by the outside-suspended type of setting, or by not less than four steel or cast-iron brackets on each side set in pairs, or suspended from beams supported on the brickwork of the boiler setting which has been carried up for this purpose, and provided that the outside wall of such a setting be not less than twenty-two (22) inches face to face of side wall, and the extension above the fire stop not less than twelve (12) inches face to face. The top of such extension or pier shall be not less than twelve by twelve (12x12) inches, covered with a suitable iron plate, and shall be carried down front and rear at an angle of not less than forty-five (45) degrees to the top of the wall.

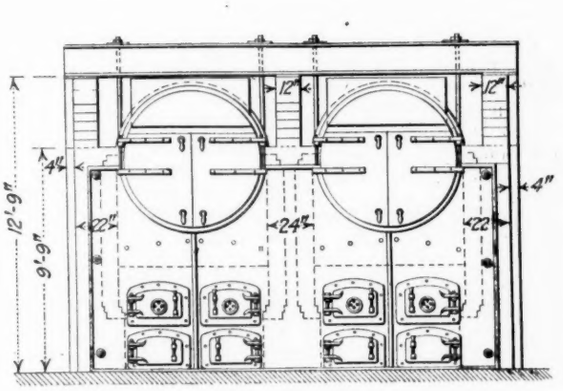
C. N. Flagg & Co. are setting boilers as shown in the engraving at the bottom of this page, and consider this method of suspension safer than lugs bearing upon only the softer portion of the wall. The petition does not contemplate the use of this form of setting where columns are required, but only as a substitute where lug support is permitted. Lugs are supported on the portion of the setting least adapted to carry a load. The load with this form of setting is more widely distributed, and it provides for movement in all directions. Rollers under lugs cannot move endwise. Mr. Flagg explains that the top of the boilers were paved with brick or silocel and that a small opening was left around the hanger to be filled with asbestos.

Mr. Jeter said that they had many explosions in which the boiler did not show any reason why it should have failed. Most of these explosions they attributed to settling of the setting. He did not believe that an accident of that character could happen to a boiler that was suspended in this way.

Mr. Luck, chairman of the Board, inquired whether this method of suspension would have any particular effect upon lug cracks, and was answered that it would have no other effect than any other method of suspending the boiler would have.

Mr. Heinrich, of the Travelers company, spoke of the accessibility of boilers suspended in this way for inspection. Mr. Flagg explained, in reply to questions by the Board, that the plate covered the top of the column or pilaster and the beams went to the outside of the wall.





Elevator Laws of the State of Pennsylvania and the City of Philadelphia

By EDWARD A. SMITH
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EXCERPTS from elevator laws of the Department of Labor and Industry, as revised to Dec. 13, 1917, for the State of Pennsylvania, except Philadelphia, Pittsburgh and Scranton, for power-driven passenger, freight and sidewalk elevators.

Load: Passenger—80 lb. per sq.ft. inside area car. Hospital Passenger—60 lb. per sq.ft. inside area car. Metal capacity plate with suitable letters, giving load, speed, size, number and material of cables. Freight—No regulation, except for automobile lifts which require platform of strength to sustain a load equal to 70 per cent. of live load concentrated at any two points 4 ft. 8½ in. apart on a line parallel to car sill.

Speed: Passenger—Shall not exceed 600 ft. per min.; over 600 ft., special permission required. Freight—125 ft. per min.; over 125 ft. special permission required; 75 ft. per min., belt and chain power-driven machines; 50 ft. per min. with horizontal self-closing hatch doors.

Current: Passenger and Freight—Not more than 250 volts permitted in any car switch or button control without special permission.

Runby at Top: Passenger—Minimum between highest point of carframe and any overhead construction: Speed feet per minute, 100, 200, 300, 400, 500 and 600; runby in feet, 5, 5, 6, 7, 7 and 8 respectively. Minimum for plunger passenger elevators 5 ft. for all speeds. Freight—Minimum between highest point of car-frame and any overhead construction shall be 4 ft.

Pit: Passenger—Minimum between bottom of car and pit when car is at lowest land: Speed feet per minute, 100, 200, 300, 400, 500 and 600; pit depth in feet, 4, 4, 4, 5, 6 and 7 respectively. Minimum for plunger passenger elevators, 4 ft. for all speeds. Freight—Minimum between underside of car and pit with car at lowest landing shall be 3 feet.

Safeties and Governor: Passenger—Safety under car, speed over 100 ft. per min. Friction clamp operated by centrifugal governor. Rise 20 ft. and speed not more than 100 ft. per min., broken rope spring grip safeties may be used. Roll safeties may be used up to and including 100 ft. per min. with governor. All safety slings to be of steel. Safe-lifting elevators to have locking device. No safeties required on plunger elevators. Freight—Over 20-ft. rise, must have safeties under car operated by centrifugal governor. Speed over 100 f.p.m., must be wedge clamp. Speed 100 ft. per min. or under, roll safety with governor may be used. Under 20-ft. rise, spring-grip safeties accepted. Sidewalk—25-ft. rise, no safety required. If located inside of building, same requirements as freight elevator.

Car Enclosure and Platform: Passenger—Enclosed on all sides and top. If grille, sides to be covered with ⅜-in. screen 6 ft. high. Entrances at not more than two sides. With gates at openings (if electric elevator), gates to have contacts. Emergency exits in top of car or, if two cars in same shaft, side exits. Nonslip floor 2 ft. from edge. Rubber tile floor is considered as nonslip. Landings and floors of cars to be lighted during operation. No horizontal or vertical compartments permitted. Freight—Enclosed solid 6 ft. high (or to car beam if lower). Top solid or No. 10 wire 1½-in mesh. Car tops not to be cut back more than 6 in. from sill, hinged section 18 in. back. More than one opening requires folding or vertical semiautomatic gate, standard height, body to conform to clear height desired, no contact. (Department of Labor, 3-17-19.) Top not required with trapdoors or with enclosed hatchways having upper floor gates extending to floor. Sidewalk—No regulation. Bow iron to be provided unless doors are opened by hand and controlling device arranged to hold car immovable until doors are opened. Not permitted inside of building.

Control: Passenger—Switch, hand-wheel or lever. Push-button for private houses only. Special permission for other push-button installations.

Gates: Passenger—Not permitted. Freight—Enclosed hatchways with fire-doors on outside of shaft require semiautomatic gates. Gates not required with fire-doors on inside of shaft. Open hatchways to have semi-automatic gates of metal or hardwood, gates to have joints reinforced with metal. Wood slats 2 in. between or 2-in. wire mesh. All gates 5 ft. 6 in. high with locks, 6 in. underclearance, 2 ft. 6 in. underclearance with trapdoors. Double blade gates to be covered with ⅜-in. mesh. At street openings or outside of building, a gate must be furnished 6 ft. high, 2-in. underclearance and covered with 1½-in. wire mesh. Exceptions when local conditions will not permit. Flexible type gates permitted. Sidewalk—Semiautomatic gates to be provided at bottom and intermediate floors. Removable railing required to prevent operation of car until rail is in place. Bow irons on car required.

Ropes: Passenger and Freight—Not less than two ropes to car and counterweight. Must be iron or steel. Governor ropes iron for all passenger. Manila for freight 100 ft. per min. or under. Swedish iron over 100 ft. per min., freight. Drum machines to have two full turns on drum when car is at lowest stop. Ends of cables clamped on inside of drum. All cables to have fastening approved by board. Cables outside of hatch to be enclosed all sides 6-ft. high. Sidewalk—Chains or cables permitted. Sheaves for cables 12 in. diameter minimum.

Equalizers: Passenger and Freight—All cables except for traction elevators.

Bumpers: Passenger and Freight—Spring, oil, air cushion or other device strong enough to absorb momentum of car loaded. No requirement for bumpers under counterweight.

Grating: Passenger and Freight—Iron, 1-in. space between bars, 2-in. wood platform or reinforced concrete under all machinery, sustaining 50 lb. per sq.ft. To cover entire hatchway, except where hatchway exceeds 100 sq.ft. must have approved railings and toe guards. If door is placed in grating it must hinge up and be self-closing and accessible from top of car. Existing gratings may remain if sufficiently strong.

Screens Not Required With Chains

Counterweight Screens: Passenger—Bottom 8-ft. high (Not required with counterbalance chains), top 10-ft. long. Where counterweights are outside of shaft must be entirely enclosed all sides. Freight—No regulation except if counterweight runs outside of shaft, must be entirely enclosed on all sides.

Stop Motion and Shaft Limits: Passenger—Drum-type machines to have machine limits. Electric machines, drum or traction, to be provided with upper and lower limits on car or shaft. Stop balls on hand rope accepted for shaft limits on existing elevators. Hydraulic plunger elevator, speed 100 ft. or less, must have independent rope with stop balls actuated by car. Rope to be attached to lever or operating sheave. On horizontal or vertical hydraulic machines, 100 ft. speed or less, use independent rope connected to operating valve and operated by traveling crosshead. If speed exceeds 100 ft., independent automatic cutoff valves to be provided. Above apply to hydro-steam and hydro-pneumatic where applicable. Freight—Limit switches for all traction machines in shaft or on car; also for drum machines above a speed of 75 ft. per minute. All drum machines to have machine limits. For hydraulic machines, same as passenger. Sidewalk—Machine limits required on electric machines. Hatchway limits not required.

Interlocks: Passenger—Approved electric or mechanical or electro-mechanical to be provided on all elevators, with approved emergency release under glass cover outside of shaft at main landing. Release to be connected with bell which will

ring continuously during release period. Release sign to be provided giving directions for use. Wires to run in conduits where possible, as per National Electrical Code. Sidewalk—Removable railing required to prevent operation of car until rail is in place at sidewalk or a device to hold car immovable until sidewalk doors are opened by hand.

Emergency Switches: Passenger—Magnet switch on controller to automatically stop machine when current is interrupted. Electric car switch to be self-centering and self-locking. Emergency switch in car in series with main line, independent of car switch, wheel or lever. Proper fuses or circuit-breakers to be furnished. Slack-cable device required on all drum machines. Freight—Signal bell in car to be operated from each floor and to be heard at any floor. Slack-cable device for drum machines. Proper fuses or circuit-breakers to be furnished. Sidewalk—Slack-cable device and hatchway limits not required.

Rope Locks: Passenger—Not permitted. Freight—Required to prevent operation of car except from landing where car stands.

Hatchway Enclosures: Passenger—Existing shafts where grills are used, to be extended full height at entrance and on sides where there are stairways and further protected by ⅜-in. mesh wire screen 6 ft. high over all moving parts within 4 in. of enclosure. Freight and Dumbwaiter—Existing shafts, solid wood ⅞ in. thick or 2-in. mesh No. 10 gage 6-ft. high allowed. Sidewalk—Lower and any intermediate landings to have substantial enclosure 6 ft. high all sides except loading.

Hatchway Doors: Passenger—Fireproof horizontal sliding doors only, as near flush with inside of shaft as possible. To be unlocked from inside only except at main landing, where key may be used to unlock from outside. Doors may have ¼-in. thick wire glass in metal frames, no one pane to exceed 250 sq.in. between mountings. Swinging doors may be used with push-button elevators. Freight—Enclosed hatchways require fire-doors inside hatch, but may be put on outside if semiautomatic gates are used. Doors may be operated by hand or by mechanical device. If manually operated, to be equipped with interlocking device. Doors not to be unlocked from outside except with removable key and except where doors have interlocks. Door sills must be beveled with metal or metal-faced wood at an angle not less than 60 deg. with horizontal. Open hatchways require automatic self-closing fire-doors except for two-story buildings or less (see paragraph on gates). Sills to be beveled as above. Sidewalk—Horizontal hatch doors at sidewalk level. No other doors required. (See paragraph on gates).

Not Permitted on Passenger Lifts

Trapdoors: Passenger—Not permitted. Freight—To be used only with shafts that are not required to be enclosed; not required for buildings two stories or less. Sidewalk—Permitted at sidewalk level.

Motor-Room Enclosure: Passenger and Freight—If over hatch to be fireproof and have fireproof door to roof and locked. No other regulation.

Automobile Lifts: Four-corner automobile freight elevators allowed for rise one story, 15 ft. rise, with maximum capacity of 5000 lb. For regular construction, same as freight elevators.

Belt Machine: Single or double-belt machines or chain permitted for freight service only. If counterweighted; up to 5000-lb. capacity, for four-story rise, centering rope required.

Operator: Competent operator over 18 years old with license where there are local laws to that effect.

Hydraulic Tanks, Valves and Cylinders: Valve chambers and cylinders designed to remove accumulation of air. Crossheads of vertical hydraulic cylinder to travel in guides of structural shapes. No continuous forged straps permitted for traveling sheaves. Use two part structural shapes. Where power pumps are used, a bypass or safety valve to be furnished to avoid increase of 15 lb. above working pressure in tank, in addition to main safety valve. Plunger heads rigidly secured to platforms. Plunger more than three sections and counterweighted to have noncorrosive cable between bottom of plunger and platform.

Plunger safe-lift elevators or emergency loads, rise more than 75 ft., to have traveling follower always midway between stuffing-box and car. Pressure tanks to have factor of safety of 5; must have water glasses. Overhead tanks to have air checks. Hydro-steam and hydro-pneumatic to comply with above as far as applicable.

Installation Prohibited: Handpower with rope grip. No elevator over passageway. No back-guide elevators permitted. No elevators operated by friction gearing or clutch. No machinery (except plunger) to be located under elevator shaft. No setscrews fastenings in lieu of keyway. Pawl-and-ratchet safety not permitted.

Philadelphia Elevator Laws

In most cases the elevator code of the City of Philadelphia, approved Apr. 15, 1908, and rules issued Aug. 28, 1919, conform with the Pennsylvania State Labor Laws, the chief exceptions being given in the following:

Safeties and Governor: Passenger—Gradual applied safety under car operated by centrifugal governor over 125 ft. per min. Instantaneous safeties may be used up to and and including 125 ft. per min., rise two stories or 30 ft. All safety slings to be of steel. Safe-lifting elevators to have locking device. No safeties required on plunger elevators. Design of safety to be approved by Department of Public Safety. Freight—Must have safeties under car operated by centrifugal governor. Speed over 125 ft. per min. must be gradual safety. Speed 125 ft. per min. or under, instantaneous safety with governor may be used. Sidewalk—25-ft. rise, no safety required. If located inside of building, same requirements as freight elevator.

Ropes: Same as state code except all cables fastened by shackles—no leaded sockets allowed except under special conditions where used in connection with traction machines, and these must have means of adjustment.

Equalizers: Passenger and Freight—All cables must be equalized or have means of equalizing same.

Bumpers: Passenger and Freight—Spring, up to and including 250 ft. per min. 10-story rise, or other approved device constructed to arrest a runaway car. Over 250 ft. per min. or 10-story rise, buffers of approved type or other approved device for arresting runaway car. No requirements for bumpers under counterweight.

Hatchway Enclosures: Passenger, freight and sidewalk—All shaftways must be fireproof excepting existing hatchways, and these can be protected by fuse link or full-automatic hatch doors. In this case the weight box has to be covered with tin and asbestos and the underside of the doors has to be covered with tin and asbestos. Existing shafts may be enlarged 33⅓ per cent. without being required to make same fireproof. Shafts to be flush with hatchway. Windows in hatchway to be covered by a substantial grille or screen.

Hatchway Doors: Passenger and Freight—Fireproof horizontal sliding or swinging doors as near flush with inside of shaft as possible. To be unlocked from inside only except at main landing, where key may be used to unlock from outside. Doors may have ¼-in. thick wire glass in metal frames, no one pane to exceed 250 sq.in. between mountings. Swinging doors may be used with push-button elevators. Existing hatchways to have doors with fuse links.

Trapdoors: Passenger and Freight—Full automatic permitted on existing hatchways. Sidewalk—Permitted at sidewalk level.

Motor-Room Enclosure: Passenger and Freight—If over hatch to be fireproof and have fireproof door to roof and locked. Free and safe access to all elevator machinery. No other regulation.

Operator: Competent operator over 18 years old with license—fee $1.00, renewal $0.25 annually. No elevator operated without certificate of inspection in car. Fine $50 for operating without certificate.

Information comes from the American Association of Engineers, which was founded in 1915, that its membership now exceeds 8800. On the first of January, 1919, the association had less than 2500 members. Within the last 11 months it has grown at a remarkable rate. On Nov. 20 the membership reached 8866. The first two weeks in December had been set aside for a country-wide drive to increase the membership by 10,000 in 13 days. The successful termination of the drive will make the association one of the largest engineering organizations in the country.

Power Supply And Generation Of The Future

It has been many a day since Chicago engineers listened to a more interesting lecture than that delivered by Dr. Charles P. Steinmetz on the evening of Oct. 29. The occasion was a joint meeting of the Chicago Section of the American Institute of Electrical Engineers and the Electrical Engineering Section of the Western Society of Engineers. Fullerton Hall, at the Art Institute, where the meeting was held, was packed to overflowing. Upon his appearance the doctor was given a rousing welcome, and the great interest that his address imparted was made evident by the innumerable questions on every conceivable source of power hurled at the speaker long after his formal talk had ended.

Introducing the subject, Dr. Steinmetz pointed out that the two essential things on which the very existence of mankind depend, are materials and energy. Both are indestructible. While they may be changed in form, neither can be created or destroyed and it is necessary to call on nature's storehouse. Materials of all kinds can be transported all over the world from their origin to the point of use. Energy, on the other hand, must first be conveyed from the place in which it is found to where it is needed and then be converted into another form of energy. There are only two forms of energy transportable—chemical energy in coal or other fuel and electrical energy. In the present day the two main sources of energy are coal and the waterfall, oil and gas playing a small part compared to coal. Power from the waterfall cannot be transported in the form of chemical energy, as in the case of coal. Unless used at the source, it must be transferred into electrical energy and distributed in this form. In fact, the development of electrical energy made possible the distant use of water power.

Briefly, the speaker referred to the present great expansion of the new industry of power generation and distribution. A great network of distributing lines cover the country. Generating stations, hydraulic and steam, are tied together and entire systems linked one to the other. To eliminate transportation of chemical energy, current is being generated at the mines and in common with other large stations, is being distributed in bulk at high voltage and then in smaller quantities at lower voltage to the points of use.

As to the amount of energy available in coal and water, the speaker gave the annual consumption of coal, including the coal equivalents of oil and gas, as 800 million tons. Piled as high and wide as the Chinese wall, this immense quantity of coal would extend entirely around the border and coast lines of the United States. The energy represented in this coal would blow this great wall 200 miles into the air.

In a crude way the total energy from water power can be estimated from the rainfall and the elevations of the various parts of the country. Figuring the energy from every drop of water in passing from its particular elevation to sea level, however, would give a potential water power of 1000 million kilowatts. Some of this water, however, would be needed for agriculture and there would be loss from seepage into the ground, evaporation, etc., so that from the water that was left, the extreme maximum that ever could be developed would be 200 million kilowatts, and not over one-half of this would be economically feasible.

In the 800 million tons of coal the chemical energy would be equivalent to about 800 million kilowatts per year, or four times the total power available from water. However, in converting the chemical energy in the coal the efficiency ranges from 10 to 40 per cent. When converted into heat the efficiency averages from 30 to 40 per cent., and only 10 to 12 per cent. for conversion into mechanical energy. The probable average is 25 per cent., so that one-quarter of 800 million, or 200 million kilowatts, would be available from coal, a figure equivalent to the maximum available water power. With the coal consumption increasing at the rate it has in recent years, the supply will soon be exhausted. To replace it entirely by water power must be a dream, although hydro-electric development will help to conserve it.

Already the country is approaching the limit of water-power development by present methods of concentrating in large stations. Much more power could be obtained by a very large number of small units scattered along every possible stream where the gradient and economic conditions warranted. These units might preferably consist of cheap hydraulic turbines coupled to induction generators which will develop electrical energy at any speed, and in attendance would require only occasional visits for general supervision. Through step-up transformers these various units could feed into the main system of the region.

One of the great problems of the future is to utilize more fully the energy in coal. The efficiency of converting chemical energy into electrical energy averages only 10 per cent., and there is a great waste of heat energy wherever coal is burned for this purpose. Heat can be transmitted only over comparatively short distances, so that the problem evolves into first getting all the electrical energy possible wherever coal is burned for heat, such as is now being done in private plants, and eventually the same method might be extended to the homes. Steam turbines coupled to induction generators would collect the electrical energy and feed it into central station mains. Credit would be allowed for the current furnished, but must be purchased at a much lower rate than that supplied by the central station, as in the latter case electrical energy is furnished when and where desired and at the proper voltage. From the private plant the current would be supplied irregularly over a separate transmission line and must be transformed to meet the requirements of the service with the possibility that there might not be a market for it when delivered.

As to other sources of energy, relatively small quantities furnished irregularly is to be expected of the wind. It is true, tower lines might be erected with an induction generator driven by an air motor on each tower, the current passing through a transformer into a general transmission system. The whole country could be covered with these lines, which could criss-cross in all directions, but there would be few places where such an arrangement would be economically feasible.

Tide mills with the accompanying reservoirs are practically hopeless as economical power producers, and wave power must be considered as irregular and impractical. Utilizing the solar energy to develop power by trapping the sun's rays under glass is hopelessly complex and inefficient, although great quantities of solar energy are available. Assuming that the sun shines one-half the time and taking into account that it is not always high up in the heavens, the total energy available from light rays from the sun has been estimated at 800,000 million kilowatts. If it were possible to collect all the solar energy not required by agriculture, say on arid territory, there would still be available 100,000 million kilowatts, more than one hundred times as much as is available in the yearly coal consumption and far more than is available from both coal and water. Development of this great resource will be left to engineers far in the future when other sources fail.

The speaker predicted that in a comparatively short time electricity will supply the world with power just like the railways now supply transportation. The country will be covered with a network of distribution lines fed from the various sources mentioned, and the cost of power will be relatively lower as the systems expand and use for all purposes becomes more general.

Professional Engineers In Iowa Must Register

Unless engineers desiring to practice in Iowa register before July 4, 1920, they will be guilty of a punishable offense should they continue to practice. All professional engineers and land surveyors are included in the law which requires registration upon their professional requirements without examination up to Jan. 4, 1920. Thereafter until July 4, 1920, technical examination before the Board of Examiners is required. After the latter date the law is in full force. The penalty is a fine of not less than $100 nor more than $500. K. C. Kastberg, Des Moines, is secretary of the Board of Examining Engineers. Other members are Seth Dean, L. M. Martin, F. W. Stubbs and Alvin Le Van.

WONDER WHO WOULD HAVE WON THE BATTLE OF BUNKER HILL WITH THIS KIND OF PUBLIC SPIRIT?
New York Tribune
The Tiny Tribune.
VOL II. DEC. 2, 1919. NO. 221
STRIKES!!
"HOW'D YOU STOP IT?"
Get Out of the Way!
COAL MINE
NOTHING DOING
COMPLIANCE
PUBLIC SUPPLY
Providence Daily Journal
—From The Providence Daily Journal
MAN, ENGINE AND THINKER
WASTE
FORCE
YOU
POWER
MEAT
FISH
FOWL
FRUIT
ENERGY
GAME
SPICES
WATER
GRAIN
VEGETABLE
EGG
SEA FOOD
DAIRY PRODUCTS
From the Scientific Point of View This Picture Is Right. AN ENGINE, Consuming a Certain Amount of Fuel in the Form of Meat, Bread, Etc., and Producing a Certain Amount of Energy. Mr. McCoy, the Artist, Shows YOU as the Furnace, Creating a Force That Goes Over to the Engine Which May Be Called Your Brain. That Brain, if Hooked to Some Useful Task by the Driving Belt of Real WORK, Does Its Share in the Big Outside Factory Called the World.
YOU Are All That Is Shown in This Picture AND YOU ARE MORE THAN THIS PICTURE SHOWS, THE CUSTODIAN, GARDENER AND DEVELOPER OF THIS EARTH.
New York American.
EDITORIALS
WINTER
RUZA.
The Tiny Tribune
The Burnt Bridge Behind Him
REPEAL OF THE DAYLIGHT SAVING LAW
COAL THAT CAN BE SAVED BY THE DAYLIGHT SAVING PLAN
ONE OF THE COAL SHORTAGE LESSONS IS TO REPAIR THAT BRIDGE!
New York American

TIMELY NEWSPAPER CARTOONS REGARDING THE COAL SITUATION

Water Power in France

The great national scheme for the development of the hydraulic resources of France which is now before the French Chamber has immense potentialities for the future of the electrical industry in that country.

Reviewing the hydraulic resources of other countries, M. Rerrier, deputy for the Isere, says that although these estimations can only be approximate, they nevertheless yield certain relative indications. Thus the average flow water power of Norway is estimated at 7,500,000 hp.; Sweden, 6,750,000 hp.; Austria-Hungary, 6,750,000 hp.; Italy, 5,500,000 hp.; Spain, 5,000,000 hp.; Switzerland, 1,500,000 hp.; Germany, 1,450,000 hp., and Great Britain, 963,000 hp. France, with 9,000,000 hp., is therefore the richest European country in waterfalls. Its resources are approximately divided as follows: Alps, 4,500,000 hp.; Central Massif Vosges and Jura, 1,700,000 hp; Pyrenees, 2,000,000 hp., and other districts 800,000 hp. Of this total of 9,000,000 hp. only 750,000 hp. was developed in 1913—350,000 hp. for transmission of power and 400,000 hp. for electrochemistry and electrometallurgy. France thus utilizes only one-tenth of her available power. In 1913 the capital employed in the hydro-electric industry totaled 800,000,000 fr. ($160,000,000), or 500,000,000 fr. ($100,000,000) in the distribution of energy and 300,000,000 fr. ($60,000,000) in electrochemical and electrometallurgical undertakings.

Since the outbreak of the war remarkable progress has been made in the utilization of French water-power resources. According to M. Cohen, between 1916 and 1918 the water power developed amounted to 450,000 hp., in 1919, 125,000 hp. is to be complete, and in 1920-21, 275,000 hp., or a total of 850,000 hp. The hydraulic power in 1921 would therefore be 1,600,000 hp., or 16 to 20 per cent. of the available power, such as it has been estimated to be. The new capital invested in the hydro-electric industry amounts to 660,000,000 fr. ($132,000,000). In 1921 there will therefore be 1,460,000,000 fr. ($292,000,000) employed in hydro-electric undertakings—865,000,000 in transmission, 500,000,000 in electrochemistry and electrometallurgy, and 95,000,000 in electric traction. These extremely remarkable results have been secured by the joint labors of private initiative and government action. The State owns and works three hydro-electric undertakings, one driving a munitions factory, another supplying a cyanide works with power, and a third for the service of the city of Toulouse.—*L'Electricien.*

New Publications

A STUDY OF THE FORMS IN WHICH SULPHUR OCCURS IN COAL

In the Chemistry Department of the Engineering Experiment Station of the University of Illinois, a thorough investigation has been made of the nature of the four sulphur compounds in coal, the quantity of each form present, and the change which characteristic forms undergo when the coal is allowed to stand or is subjected to coking. The following methods were developed for the quantitative analysis of each form of sulphur: (1) The sulphate sulphur was determined by extraction of the coal with dilute hydrochloric acid. (2) The pyritic sulphur was determined by extraction of the coal with dilute nitric acid; it having been found that nitric acid of a certain dilution has a selective action on sulphur combined as iron pyrites. (3) The resinic sulphur was determined by extraction of the coal with phenol. (4) The humus sulphur was determined either by a direct method or by the difference between the sum of the other three forms and the total sulphur in the coal.

The devising of such methods of analysis has been much sought after in recent years by coal and coke investigators, but without satisfactory results up to the present time. The methods here proposed have been put to extended tests with exceedingly satisfactory results. These investigations, which were made by A. R. Powell with Prof. S. W. Parr, are published in Bulletin 111 of the Engineering Experiment Station. Copies of this bulletin may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

Miscellaneous News

Paducah City, Ky., voted $260,000 for improvement to its electric light and power plant. The improvements are to be started at once.

Kentucky and West Virginia Power Co., Lothair, Ky., recently increased to $6,000,000 capital, will erect a large power-plant addition, beginning at once. R. E. Breech, president, is located at 30 Church St., New York, and F. R. Weller, consulting engineer, Hibbs Building, Washington, D. C. The company will extend high-powered transmission lines into Elkhorn and Hazard coal fields, supplying 90 per cent of the operating coal companies. It is also planned to extend lines into the Elkhorn field of West Virginia. The company recently took over two good-sized power companies in the latter state.

The Monongahela Valley Traction Co.'s plant at Parkersburg at the present time has equipment installed to develop a load of 5000 kw. or about 6700 hp. This is considerably in excess of the present demand, as the load averages about 8600 kw. during the day and only about 2000 during the night. However, in anticipation of an increased power demand in the future, the company is at present getting ready to double their present capacity by installing equipment necessary to bring the capacity up to 10,000 kw. This will mean that the company will be able to offer attractive power rates to incoming industries, and also that they will be able to supply the demand when the industries arrive.

The National Association of Stationary Engineers' Educational Committee has issued a 46-page booklet of its lantern slide lecture on "The Diesel Engine." This contains about fifty slides showing the Diesel engine in its various stages, makes and sizes from the first American-built Diesel of 60 hp. to the higher horsepowers of the present day. Copies of this lecture are for sale by the N. A. S. E. Educational Committee, 811 W. Dayton St., Madison, Wis., at 25 cents to members and 50 cents to nonmembers.

Business Items

J. G. White & Co., Inc., announces the removal of its offices to 37 Wall St., New York City.

The Ingersoll-Rand Co., New York City, has opened a branch office in the Sam Houston Life Building, Dallas, Texas, with R. H. Brown, Jr., as manager. Previous to this Mr. Brown was connected with the company's St. Louis office.

No O-10 Ed M Dept Bus Notes

The M. H. Detrick Co., Chicago, Ill., have completed arrangements for representation on the Pacific Coast with S. Herbert Lanyon, sales engineer, 507 New Call Building, San Francisco, Cal. They have also just recently arranged with H. A. Paine, 1302 Nance St., Houston, Texas, for representation in Texas.

T. H. Burton, formerly connected with the Page Boiler Co., of Chicago, announces the organization of the De Pere-Burton Co., of Milwaukee, for the purpose of manufacturing the Burton type of boiler, with improvements over his former designs. The new firm has large manufacturing capacity and a shop with a record for successful bailer manufacturing for a number of years.

Trade Cataolgs

The Kerr Turbine Co., Wellsville, N. Y., has issued a 27-page catalog, entitled "Kerr Economy Marine Equipment," which fully illustrates and describes in detail all about Kerr marine turbines.

The Nashua Machine Co., Nashua, N. H., has issued a 15-page booklet on "The New Bundy Steam Traps," which fully describes this particular type of trap and gives ratings with actual tests with traps ranging in size from 5 to 250 lb.

The Richardson-Phenix Co., Milwaukee, Wis., has issued an interesting 16-page catalog describing the "Nokut Pump Valve." It gives list prices, sizes and dimensions of various types and sizes of pump valves. A copy may be had free upon request.

The Black & Decker Manufacturing Co., Baltimore, Md., has issued its full catalog, giving a complete description, with illustrations, of its electric air compressors, portable electric drills, and electric valve grinders. Copy may be had free upon application.

The Allis-Chalmers Co., Milwaukee, Wis., has issued bulletin No. 1632-C on "Centrifugal Pumps" and bulletin No. 1537 on "Details of Allis-Chalmers Oil Engines—Diesel Type." Both bulletins are well illustrated and treat their respective subjects well. Copies may be had free upon application.

Walter A. Zelnicker Supply Co., St. Louis, Mo., has issued a 56-page bulletin, No. 270, entitled "The Nation's Market Place," which lists rails, locomotives and their accessories, machinery for power and industrial plants, contractors equipment, pipe of all kinds, steel piling, tanks, etc. Copy free upon request.

The Clarage Fan Co., Kalamazoo, Mich., is sending out upon request a little booklet entitled "A Dance, A Fan and the Girl." A bit of romance makes the story worth reading. Features of the fan are brought into the story in an interesting fashion. Emphasis is placed on the good points of the bearings and the fact that the fans are adjustable and reversible.

The Standard Oil Co. has issued a very interesting 112-page illustrated booklet entitled "Fuel Oil Installations." The object of the work is to give prospective users of fuel oil a practical knowledge of the factors governing both the installation and operation of fuel-oil burning plants. Under each type of plant are mentioned the various advantages in the use of fuel oil. The main considerations entering into the question of fuel-oil burning are treated in a general and practical manner. Sufficient details are given of typical plants so that prospective users can form an accurate estimate, governed by local conditions, of the cost involved in making the installation, as compared to savings effected in operation by using oil fuel. Chapters on "Fuel Oil and Its Properties," "Advantages in the Use of Fuel Oil," "Fuel Oil Burners and Methods of Atomization," "Equipment Required in Oil Burning Systems," "Oil Burning Boiler Plants," "Special Applications of Oil Burning Installations," and Results of Boiler Tests Burning Oil Fuel" are well covered. A comparison between the equivalent cost values of coal and oil is made in Chapter II, which should be of value in making a decision as to the proposed use of fuel oil in a plant. Seven useful tables on the following subjects are given: "Relative Value of Coal and Oil," "Amount of Air Required Per Pound of Various Fuels," "Calorific Values and Specific Gravity of Various Fuels," "Properties of Saturated Steam," "Sizes of Oil Fuel Stacks," "Tank Capacities," "Conversion Tables of English to Metric Units."

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$8.20@$8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	3.60@ 3.80
Rice	2.30@ 2.50
Barley	1.25

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.85@$3.35	$3.15@$3.60
F.o.b. Philadelphia, gross tons	5.05@ 5.60	5.35@ 5.90
F.o.b. New York, gross tons	5.40@ 5.95	5.75@ 6.25
Alongside Boston (water coal), gross tons	7.00@ 7.75	7.60@ 8.00

Pocahontas and New River are practically off the market for coastwise shipment, but are quoted at $6.25@$7.00.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

Anthracite

	Company Coal
Broken	$7.80@$8.25
Egg	8.20@ 8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	5.15
Rice	4.50
Barley	4.85
Boiler	4.85

Bituminous

	Spot
South Fork (best)	$3.25@$3.50
Cambria (best)	3.00@ 3.25
Cambria (ordinary)	2.60@ 2.90
Clearfield (best)	3.00@ 3.25
Clearfield (ordinary)	2.60@ 2.90
Reynoldsville	2.85@ 2.90
Quemahoning	3.25@ 3.50
Somerset (medium)	3.00@ 3.25
Somerset (poor)	2.50@ 2.75
Western Maryland	2.50@ 2.75
Fairmont	2.25@ 2.50
Latrobe	2.60@ 2.90
Greensburg	2.75@ 3.00
Westmoreland ¾ in.	3.40@ 3.50
Westmoreland run-of-mine	2.75@ 3.00

PHILADELPHIA—Anthracite prices are practically the same as those listed above for New York. Bituminous coal prices vary according to district from which they are mined. For ordinary slack the price is $2.45@$2.55; lump, $3.00@$3.35.

BUFFALO—

Anthracite

	On Cars, Gross Ton	At Curb, Net Ton
Grate	$8.55	$10.80
Egg	8.80	10.65
Stove	9.00	10.85
Chestnut	9.10	10.85
Pea	7.75	9.30
Buckwheat	5.70	7.75

Bituminous

Allegheny Valley	$4.80
Pittsburgh	4.65
No. 8 Lump	4.65
Mine Run	4.80
Slack	4.10
Smokeless	4.60
Pennsylvania Smithing	5.70

CLEVELAND—Prices of coal per net ton delivered in Cleveland are:

Anthracite

Egg	$11.75@$11.90
Chestnut	12.00@ 12.00
Grate	11.75@ 11.90
Stove	11.90@ 12.10

Pocahontas

Mine-run	$7.50

Domestic Bituminous

West Virginia splint	$8.50
No. 8 Pittsburgh	$6.60@ 6.90
Masillon lump	8.25@ 8.50
Coshocton lump	7.15

Steam Coal

No. 6 slack	$5.25@$5.50
No. 8 slack	5.10@ 5.50
Youghiogheny slack	5.25@ 5.50
No. 8 ¾ in.	5.70@ 6.00
No. 6 mine-run	5.25@ 5.50
No. 8 mine-run	5.75

Only coal available is mine-run Pocahontas.

MIDDLE WEST—Chicago quotations, F.o.b. cars at mine:

	Springfield Carterville Williamson Franklin Saline Harrisburg	Fulton Peoria	Grundy La Salle Bureau Will
Lump	$2.55@$2.70	$2.95@$3.10	$3.25@$3.40
Washed	2.75@ 2.90	.....	3.45@ 3.60
Mine Run	2.35@ 2.50	2.75@ 2.90	3.00@ 3.15
Screenings	2.05@ 2.20	2.35@ 2.50	2.75@ 2.90

New Construction

PROPOSED WORK

Me., Biddeford—The Saco-Lowell Co., 77 Franklin St., Boston, is having plans prepared for the construction of a 2 story machine shop and foundry. A steam heating system will be installed in same. Total estimated cost, $200,000. Lockwood, Greene & Co., 60 Federal St., Boston, Engrs.

Mass., Cambridge—C. T. Main, Engr., 201 Devonshire St., Boston, will soon award the contract for the construction of a 2 story, 86 x 134 ft. boiler house at the plant of Lever Brothers Co., 176 Broadway.

Mass., Medford—The Malden Electric Co., 201 Devonshire St., Boston, plans to build a 1 and 2 story, 58 x 62 ft. sub-station and office building on Salem St. Work will not be started until March, 1920. C. H. Tierney & Co., 201 Devonshire St., Boston, Engr.

Mass., Quincy—The city of Boston, Children's Institute Department, will soon award the contract for the construction of a 3 story, 95 x 115 ft. administration building at the Suffolk School for Boys on Rainsford Island. A steam heating system will be installed in same. Total estimated cost, $200,000. James Purdon, 8 Beacon St., Boston, Arch.

Conn., Bridgeport—The Board of Education will soon award the contract for the construction of a 2½ story, 118 x 130 ft. school addition on Kelsey St. A steam heating system will be installed in same. Total estimated cost, $155,000. F. A. Cooper, 1024 Main St., Arch.

Conn., Hartford—A. Steiger, 345 Main St., Springfield, Mass., is having plans prepared for the construction of a 90 x 150 ft. department store on Main and Pratt Sts. A steam heating system will be installed in same. Total estimated cost, $500,000. Buckman & Kahn, 56 West 45th St., New York City, Engr.

Conn., New Haven—A. C. Gilbert, Blatchey Ave., is having plans prepared for the construction of a 3 story, 80 x 100 ft. factory. A steam heating system will be installed in same. Total estimated cost, $80,000. Lockwood, Greene & Co., 101 Park Ave., New York City, Arch. and Engr.

N. Y., New York—The Board of Education, 500 Park Ave., New York City, received bids for installing heating and ventilating apparatus in Public School No. 6, Tremont Ave (Bronx Boro.), from Daniel J. Rice, 405 Lexington Ave., $61,393; E. Rutzler Heating Co., 404 East 49th St., $64,423; Gillis & Geoghagan, 537 West Broadway, $67,269.

N. Y., Brooklyn—The Borough of Brooklyn, Borough Hall, plans to build a public bath house in McCarren Park (Greenpoint). A steam heating system will be installed in same. Total estimated cost, $200,000. H. Bacon, 101 Park Ave., New York City, Engr.

N. Y., Flushing—The Knickerbocker Ice Co., 1480 Broadway, New York City, has awarded the contract for the construction of a 1 and 2 story, 120 x 140 ft. ice plant on Collins Pl., to Post & McCord, 101 Park Ave., New York City. Separate bids for installing heating system will be received. Total estimated cost, $150,000.

N. Y., Long Island City—C. E. Shepard, 311 Hudson St., will soon award the contract for the construction of a 3 story factory on Van Alst Ave. A steam heating system will be installed in same. Total estimated cost, $250,000. H. Balcom, 10 East 47th St., New York City, Engr.

N. Y., New York—The 145th St. Theatre Corporation, 120 Broadway, is having plans prepared for the construction of a 2 story, 88 x 172 ft. theatre and garage at 246-262 West 145th St. A steam heating system will be installed in same. Total estimated cost, $300,000. F. W. Lamb, 644 8th Ave., Arch.

N. Y., New York—The 75 Maiden Lane Corporation, c/o A. F. Gilbert, Arch., 80 Maiden Lane, will soon award the contract for the construction of a 12 story office building at 73-79 Maiden Lane. A steam heating system will be installed in same. Total estimated cost, $1,200,000.

N. Y., New York—The Advance Novelty Candy Manufacturing Co., 511 East 72nd St., plans to build a 5 story, 100 x 225 ft. factory on 138th St. and Willow Ave. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., New York—The Allerton House Corporation, 143 East 39th St., will build a 16 story, 100 x 200 ft. hotel, at 551-553 Madison Ave. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Work will be done by day labor.

N. Y., New York—Belleview State Hospital, New York City, rejected all bids for the installation of a heating and ventilating systems in Fordham Hospital. Estimated cost, $15,000. Work will be readvertised.

N. Y., New York—The Broad Street Hospital, 127 Broad St., is having plans prepared for the construction of a 10 story, 45 x 75 ft. addition at 123-125 Broad St. A steam heating system will be installed in same. Total estimated cost, $300,000. W. N. Smith, 101 Park Row, Arch. and Engr.

N. Y., New York—The Commonwealth Construction Co., 18 East 41st St., will build a 200 x 300 x 200 x 350 ft. hotel on Broadway and 7th Ave., between 56th and 57th Sts. A steam heating system will be installed in same. Total estimated cost, $15,000,000. Work will be done by day labor.

N. Y., New York—B. S. Moss, 729 7th Ave., is having plans prepared for the construction of a 3 story theater and office building on 176th St., Carter, Tremont and Webster Aves., Bronx Borough. A steam heating system will be installed in same. Total estimated cost, $750,000. DeRosa & Pereira, 110 West 40th St., Engr. and Arch.

N. Y., New York—Oppenheim Collins & Co., 35 West 34th St., is having plans prepared for the construction of an 8 story, 50 x 100 ft. department store at 24 West 57th St. A steam heating system will be installed in same. Total estimated cost, $400,000. Buchman & Kahn, 56 West 45th St., Arch. and Engr.

N. Y., New York—The Victory Hall Association, 32 Nassau St., plans to build a 4 story, 197 x 400 ft. Memorial Hall on Pershing Square. A steam heating system will be installed in same. Total estimated cost, $5,000,000. G. W. Wingate, Arch.

N. Y., New York—The Western Import Co., 1457 Broadway, plans to build 38 stores and 1 theater on Simpson St., Westchester Ave. and Southern Blvd., Bronx Borough. Steam heating systems will be installed in same. Total estimated cost, $115,000 and $400,000, respectively.

N. Y., New York—Sam S. and Lee Shubert, 225 West 44th St., are having plans prepared for the construction of a theatre on 49th St., west of Broadway. A steam heating system will be installed in same. Total estimated cost, $500,000. Herbert J. Krapp, 116 East 16th St., Arch. and Engr.

N. Y., New York—The Victory Association, 32 Nassau St., is having plans prepared for the construction of a 4 story, 197 x 400 ft. hall on Pershing Square. A steam heating system will be installed in same. Total estimated cost, $10,000,000. Herts & Robinson, 331 Madison Ave., Arch. and Engr.

N. Y., Poughkeepsie—The Dutch Reformed Church is having plans prepared for the construction of a church. A steam heating system will be installed in same. Total estimated cost, $200,000. W. B. Chambers, 111 East 40th St., New York City, Engr.

N. J., Bordentown—The State of New Jersey plans to build a 1 story, 42 x 110 ft. trade school here. Two boilers will be installed in same. Total estimated cost, $20,000. F. H. Bent, 142 West State St., Trenton, State Arch.

N. J., Jersey City—The DesLauriers Column Mould Co., Woolworth Bldg., New York City, is having plans prepared for the construction of an 8 story, 100 x 200 ft. factory. A steam heating system will be installed in same. Total estimated cost, $400,000. Funk & Wilcox, Old South Bldg., Boston, Mass., Arch.

N. J., Trenton—The Y. M. C. A., 2 West 45th St., New York City, is having plans prepared for the construction of a new building, here. A steam heating system will be installed in same. Total esti-

mated cost, $250,000. Jallade & Lindsey, 37 Liberty St., New York City, Arch. and Engr.

Pa., Chester—H. Childs Hodgens, Arch., 130 South 15th St., Philadelphia, will soon award the contract for the construction of a 2 story, 120 x 160 ft. theatre, dance hall and stores, for the Nixon Theatre Co., 52nd and Market St., Philadelphia. A steam heating system will be installed in same. Total estimated cost, $110,000.

N. J., Jersey City—The First National Bank, is having plans prepared for the construction of a 10 story, bank and office building on Exchange Pl. A steam heating system will be installed in same. Total estimated cost, $1,000,000. A. C. Bosson, 366 5th Ave., New York City, Engr.

N. J., Plainfield—The Y. M. C. A., 215 West 23rd St., New York City, is having plans prepared for the construction of a 3 story building. A steam heating system will be installed in same. Total estimated cost, $200,000. Jallade & Lendsey, 37 Liberty St., New York City, Engr.

Md., Baltimore—The Terminal Warehouse Co., Davis and Pleasant Sts., is having plans prepared for the construction of a 6 story, 120 x 600 ft. warehouse on Boston St., near Clinton St. Contract for lighting and heating will be sub-let. Total estimated cost, $300,000. Owens & Sisco., 1605 Continental Bldg., Arch.

Md., Baltimore—The Union Memorial Hospital Trustees are having plans prepared for the construction of a 4 story, 350 x 400 ft. hospital on 34th, 35th and Calvert Sts. and Guilford Ave. A steam heating system will be installed in same. Total estimated cost, $750,000. S. Rowland, Calvert Bldg., Chm. J. E. Sperry, 409 Calvert Bldg., Arch.

D. C., Washington—Duncan Candler, Arch., 753 5th Ave., New York City, will soon award the contract for the construction of a 7 story hotel for the War Council National Board of the Y. M. C. A., 341 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $800,000.

Ga., Columbus—The Merchants & Mechanics Bank, 1205 Broad St., had plans prepared for the construction of a bank building. A steam heating system will be installed in same. Total estimated cost, $150,000. Mowbray & Uffinger, 56 Liberty St., New York City, Arch. and Engr.

Ohio, Cleveland—The Erie Realty Co., Erie Bldg., has purchased a site at the rear of the Bangor Bldg., and plans to construct a 1 story, 78 x 150 ft. market house on same. A refrigerator plant will be installed in same. Total estimated cost, $150,000. Walker & Weeks, Euclid Bldg., Arch.

Ohio, Cleveland—The Euclid 17th Co., 214 Williamson Bldg., is having plans prepared for the construction of a 3 story, 124 x 176 ft. theater on East 17th St. and Euclid Ave. A steam heating system will be installed in same. Thomas W. Lamb, 1323 Euclid Ave., Arch.

Ohio, Cleveland—The W. S. Ferguson Co., Arch., 1900 Euclid Bldg., will receive bids until December 29 for the construction of an 8 story, 100 x 150 ft. garage on Huron Rd. and East 12th St. for the G. A. Tenbusch Realty Co., 1836 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $600,000.

Ohio, Cleveland—George A. Greible, Arch., Sloan Bldg., will receive bids about December 17 for the construction of a 6 story, 60 x 140 ft. commercial building at 640 Huron Rd., for the Huron Sixth Co., c/o of Architect. A steam heating system will be installed in same. Total estimated cost, $450,000.

Ohio, Cleveland—George D. Koch & Son Co., 10300 Euclid Ave., plans to build a 3 story, 60 x 180 ft. furniture store building on 100th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ohio, Cleveland—The Lake Shore Banking & Trust Co. has purchased a site on East 79th St. and Euclid Ave., and plans to construct a 3 story bank building on same. A steam heating system will be installed in same. Total estimated cost, $100,000. J. H. Jones, Osborn Bldg., Pres.

Ohio, Cleveland—The Plymouth Congregational Church, 3048 Chadbourne Ave., is having plans prepared for the construction of a 2 story, 100 x 200 ft. church on Drexmore Rd. A steam heating system will be installed in same. Total estimated cost, $250,000. C. S. Schneider, 2258 Euclid Ave., Arch.

Ohio, Cleveland—The Russ Co., 5511 Walworth Rd., manufacturer of beer pumps, is having plans prepared for the construction of a 4 story, 120 x 160 ft. factory addition. A steam heating system will be installed in same. Total estimated cost, $100,000. G. E. Rider Co., Century Bldg., Arch.

Ohio, Cleveland—T. H. Towell, Cadillac Bldg., is having plans prepared for the construction of a 2 story, 200 x 220 ft. sales and service building on East 21st St. A steam heating system will be installed in same. Total estimated cost, $300,000. H. E. Shimmis, 2031 Euclid Ave., Engr. and Arch.

Ohio, Cleveland—The Union Tire & Rubber Co., Hippodrome Bldg., is having plans prepared for the construction of a 3 story, 165 x 190 ft. rubber plant here. A steam heating system will be installed in same. Total estimated cost, $125,000. Osborn Engineering Co., 2848 Prospect Ave., Engr.

Ohio, Cleveland—F. W. Wallace, Citizens Bldg., plans to build a 14 story, 101 x 146 ft. office building on East 4th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

Ohio, Cleveland—The Wilbrand Co., 2031 Euclid Ave., plans to construct a 2 story, 150 x 200 ft. commercial building at 1910 East 21st St. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ohio, Cleveland—The city will soon award the contract for furnishing one 20,000,000 gallon high service steam turbine, reduction gear driven centrifugal pump. Edward Shattuck, City Engr.

Ohio, Cleveland—The Board of Education will receive bids until December 29 for the construction of a 2 story, 98 x 156 ft. school addition on Warner Rd. One sectional cast heating boiler will be installed in same. Total estimated cost, $200,000. F. G. Hogan, Director of Schools. W. R. McComack, East 6th St. and Rockwell Ave., Arch.

Ohio, Cleveland—The city will receive bids until December 19 for the construction of twelve 8 x 50 ft. grit chambers, flow channels, pump wells and buildings for same, also for the installation of pipe and pump equipment, in connection with the proposed easterly sewage treatment works, foot of East 40th St. George Gascoigne, 618 City Hall, Engr.

Ohio, Cleveland—The City Ice Delivery Co. will receive bids after January 1 for the construction of a 1 story, 5000 ton ice storage plant, on Cedar and Lee Rds. Estimated cost, $100,000. Harry Novall, Cadillac Bldg., Pres. C. C. Coneby, Cadillac Bldg., Arch. and Engr.

Ohio, Cleveland—The Cleveland Railway Co., Leader News Bldg., is having preliminary plans prepared for the construction of a 1 story, 50 x 50 ft. automatic sub-station, on Detroit Ave. and West 65th St. Total estimated cost, $60,000. G. L. Radcliffe, Leader News Bldg., Gen. Mgr. L. P. Crocelius, 650 Leader News Bldg., Arch. and Engr.

Ohio, Cleveland—The Euclid East 46th St. Market House Co. plans to build a 1 story, 90 x 350 ft. public market house on Euclid Ave. and East 46th St. A steam heating system will be installed in same. Total estimated cost, $200,000. Charles Kamp, East 46th St. and Euclid Ave., Mgr.

Ohio, Cleveland—The May Co. plans to build a 2 story, 200 x 450 ft. department store addition on East 1st St. and Euclid Ave. The present steam heating plant will be extended. Total estimated cost, $400,000. Graham, Anderson, Propst & White, 80 East Jackson, Chicago, Ill., Archs.

Ohio, Cleveland—S. H. Strauss, 14505 Woodworth Rd., will receive bids about December 17 for the construction of two 2 story, 35 x 190 ft. hotels at Stop 113, Euclid Line. A steam heating plant will be installed in same. Total estimated cost, $140,000. Max Weis, 618 Union Bldg., Arch.

Ohio, Cleveland Heights (Warrensville P. O.)—The Board of Education will soon award the contract for the installation of three 250 hp. water tube boilers with stokers in the Lee Rd. School. E. K. Bryan, c/o Lee Rd. School, Engr.

Ohio, Dayton—L-C-R Storage Battery Co., North St. Clair St., plans to construct a 1 story, 70 x 150 ft. battery service station on Ludlow and Franklin St. Estimated cost, $75,000.

Ohio, Dayton—The Miami Ice Delivery Co., Ludlow Bldg., plans to build a 2 story ice manufacturing plant with 60 ton daily capacity and 5000 ton storage capacity, on 3rd St. Total estimated cost, $100,000.

Ohio, Fairport—The Board of Education will receive bids until December 23 for the construction of a 2 story, 84 x 126 ft. public school on 4th and Vine Sts. A steam heating system will be installed in same. Total estimated cost, $100,000. C. W. Bates, 701 National Bank Bldg., Wheeling, W. Va., Arch.

Ohio, Kent—The Board of Education is having plans prepared for the construction of a 3 story, 75 x 190 ft. high school. A steam heating system will be installed in same. Total estimated cost, $275,000. Mills & Millspaugh, Marshall Bldg., Cleveland, Engr.

Ohio, Lakewood (Cleveland P. O.)—The Board of Education is having preliminary plans prepared for the construction of two 3 story high schools. Steam heating systerms will be installed in same. Total estimated cost, $600,000. P. T. Harrold, c/o Citizens Bank, Cleveland, Clk. C. W. Hopkinson, Rose Bldg., Cleveland, Arch.

Ohio, Silver Lake (Cuyahoga Falls P. O.)—The village received bids for the construction of two 1 story, 17 x 17 ft. pump houses, also furnishing deep well pumps, gate valves, etc., from the Gangl Construction Co., 2nd National Bank Bldg., Akron, $10,238; Aljer & Tillman, Guardian Bldg., Cleveland, $11,478.

Ohio, Steubenville—The Steubenville Bank & Trust Co. will soon award the contract for the construction of a 12 story, 53 x 195 ft. bank and office building on Main St. Two 300 h. p. boilers and 3 electric elevators with table and motors will be installed in same. Total estimated cost, $750,000. Peterson & Clare, National Bank Bldg., Arch.

Ohio, Warren—The General Fire Extinguisher Co. is having plans prepared for the construction of a 2 story, 100 x 200 ft. foundry. Electric motors to furnish power, blower, conveyor, etc., will be installed in same. Total estimated cost, $350,000. H. M. Lane Co., 701 Owen Bldg., Detroit, Engr.

Ill., Chicago—M. Born & Co., 540 South Wells St., is having plans prepared for the construction of a 12 story, 44 x 120 ft. addition to its clothing factory on Harrison and Wells Sts. An addition will be built to the present steam heating system. Total estimated cost, $850,000. A. S. Alshuler, 28 East Jackson, Arch.

Mich., Detroit—The City Water Board received bids for furnishing seven sets of revolving screens for low lift pumping station at waterworks, from the Link Belt Co., 732 Dime Bank Bldg., $26,400; the Chain Belt Co., 11th Ave. Viaduct, Milwaukee, Wis., $26,850.

Mich., Detroit—C. Howard Crane and E. G. Kiehler, Archs., Huron Bldg., will soon award the contract for the construction of a 2 story, 133 x 200 ft. theatre on Woodward Ave., for the Allen Theatre Enterprises, Richmond St., Toronto, Ont. A steam heating plant, to consist of boiler, fan, vacuum pump and accessories, will be installed in same. Total estimated cost, $1,000,000.

Mich., Detroit—The I. O. O. F. Lodge No. 373, c/o Peter Wilhemson, 1977 Kercheval Ave., has engaged Aaron H. Gould & Son, Archs. and Engrs., 611 Empire Bldg., to prepare plans for the construction of a 3 story lodge and club building on Kercheval Ave. Steam heating equipment will be installed in same. Total estimated cost, $250,000.

Mich., Detroit—The Jefferson Ave. Presbyterian Church, c/o C. McMath, Chm. of Bldg. Com., plans to build a 2 story church on Jefferson Ave. near Parkview Ave. Steam heating equipment will be installed in same. Total estimated cost, $500,000.

Mich., Detroit—The Odd Fellows Association, c/o Herman Kapp, 117 West Fort St., retained Andrew Clubb, Arch., Grebel Bldg., to prepare plans for the construction of a 3 story association temple on Wheeler and Lafayette Sts. Steam heating equipment will be installed in same. Total estimated cost, $120,000.

Mich., Flint—The Flint Council of Odd Fellows is having plans prepared for the construction of a 3 story, 66 x 116 ft. lodge house on Harrison and 4th St. A steam heating system will be installed in same. Van Leven, Schilling & Keough, 1115 Union Trust Bldg., Archs. and Engrs.

Mich., Pontiac—St. Michael's Parish, c/o Bishop Michael J. Gallagher, 31 Washington Blvd., Detroit, plans to construct a 2 story school, church and parish house on Chamberlain and Edison Sts. Steam heating equipment will be installed in same. Total estimated cost, $150,000.

Mich., Port Huron—A. Fraser, Military St., has purchased a site on Military and Pine Sts., and plans to construct a 4 story office building on same. A steam heating system will be installed in same. Total estimated cost, $100,000.

Mich., Port Huron—The Knights of Columbus, Military St., have purchased a site on Superior and Broad Sts., and plan to construct a 3 story, 100 x 130 ft. club house on same. A steam heating system will be installed in same. Total estimated cost, $100,000.

Wis., Chippewa Falls—E. G. Pannier & Son, 916 Prairie St., is having plans prepared for the construction of a 2 story, 130 x 200 ft. office building. A steam heating system will be installed in same. Total estimated cost, $125,000. Schlinz & Bailey, 53 West Jackson Blvd., Chicago, Arch.

Wis., Milwaukee—Cahill & Douglas, Engrs., Gross Bldg., are preparing plans for 200 hp. generator, about 60 motors, totaling 250-300 hp., and a prime mover, for Mueller & Son Co., 361 Canal St.

Wis., Milwaukee—The Walsh Harness Co., 425 East Water St., is having plans prepared for the construction of a 1 story, 50 x 200 ft. factory on Keefe Ave. A power plant will be installed in same. Total estimated cost, $60,000. M. Tullaren & Sons, 425 East Water St., Archs. and Engrs.

Wis., Milwaukee—George Ziegler Co., 362 Florida St., is having plans prepared for the construction of a 7 story, 80 x 115 ft. addition to its factory. The present steam heating system in same will be extended. Total estimated cost, $250,000. Brust & Philipp, Free Press Bldg., Archs. and Engrs.

Ia., Cushing—A. H. Bullock, Secy., of the Board of Education, is having plans prepared for the construction of a 3 story school. A steam heating system will be installed in same. Total estimated cost, $107,000. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, Arch.

Ia., Des Moines—The city received bids for furnishing pipe and laying 32,256 ft. of sanitary sewer, also furnishing and installing a two-unit electrically operated centrifugal pumping plant, in connection with the proposed South Side sewerage system, from Alexander & Higbie, 2733 Sixth Ave., $178,346; National Construction Co., Davenport, $178,941; O. P. Herrick, 704 Observatory Bldg., $183,731.

Ia., Des Moines—The Executive Council of Iowa, State Capitol Bldg., will soon award the contract for furnishing and installing chain grate stokers, superheaters, stoker arches and soot blowers in the power and heating plant to be erected on the grounds of the Iowa State Capitol. R. E. Bales, Secy.

Ia., Odebolt—The town will soon award the contract for the construction of a sanitary sewerage system consisting of 1 flush tank, complete ejection outfit with pump and house, all appurtenances, etc. L. R. Bassett, Clk. W. E. Standeven, 619 Bee Bldg., Omaha, Neb., Engr.

Ia., Washta—J. K. McGonigae, Secy., of the Board of Education, is having plans prepared for the construction of a 3 story, 58 x 102 ft. school. A steam heating system will be installed in same. Total estimated cost, $100,000. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, Arch.

Minn., Duluth—T. D. Whittier, Chn. of Bldg. Com., will receive bids until January 2 for the construction of a 2 story, 70 x 134 ft. church on West 2d St., for the Second Presbyterian Church, West Superior St. A steam heating system will be installed in same. Total estimated cost, $100,000. Halstead & Sullivan, Palladio Bldg., Arch. and Engr.

Minn., St. Paul—The Board of Education is having plans prepared for the construction of a 3 story, 160 x 239 ft., high school, to be known as Westside High School. A steam heating system will be installed in same. Total estimated cost, $250,000. C. A. Hausler, City Hall, Arch.

Minn., St. Paul—M. P. Ryan, owner of the St. Michael Hotel, 512 St. Peter St., is having plans prepared for the construction of a 10 story, 100 x 102 ft. addition to same. A steam heating system will be installed in same. Total estimated cost, $200,000. Mark Fitzpatrick, 17 West 9th St., Arch.

Minn., Richfield—Independent School District No. 143 is preparing plans for the construction of a 3 story, 57 x 174 ft. grade school with a 73 x 90 ft. wing. A steam heating system will be installed in same. Total estimated cost, $200,000.

Kan., Aurora—The city plans to construct a waterworks system, pumping plant, steel tank, etc. Total estimated cost, $30,000.

Kan., St. Francis—The city voted $55,000 bonds and is having plans prepared for the construction of an electric-light plant. The Henningson Engineering Co., National Bldg., 12th and Harney Sts., Omaha, Neb., Engr.

Neb., Hastings—The Masonic Cathedral Association is having plans prepared for the construction of a 4 story, 125 x 232 ft. masonic temple. A steam heating system will be installed in same. Total estimated cost, $500,000. Keffer & Jones, 204 Masonic Temple, Des Moines, Ia., Arch.

Neb., Omaha—The Baker Ice Machine Co., care of J. L. Baker, 19th and Nicholas Sts., plans to build a 2 story, 140 x 555 ft., office building and ice manufacturing plant. Total estimated cost between $350,000 and $400,000.

Mont., Hysham—The Hysham Irrigation District plans to irrigate 6,000 acres by means of pumping stations. Estimated cost, $260,000. B. C. Lillis, 239 Black Ave., Billings, Engr.

Mont., Missoula—The DeSmet Irrigation District plans to irrigate about 5,000 acres by constructing two pumping stations, each lifting water 70 ft. Estimated cost, $150,000. C. F. Farmer, 315 Tremont St., Engr.

Mo., St. Louis—The American Bakers' Machinery Co., Clinton and 9th Sts., is preparing plans for the construction of a 2 story, 100 x 300 ft., factory for the manufacture of ovens, on Kings Highway. A coke or oil burning power plant will be installed in same. Total estimated cost, $75,000.

Okla., Minco—The city voted $11,000 bonds to extend the waterworks system and improve the electric plant.

Wash., Centralia—The Sherman County Light & Power Co. is having preliminary surveys made for the erection of a steam plant adjoining the plant of the Eastern Railway & Lumber Co. Estimated cost, $150,000.

Ore., Astoria—The Port Commission plans to install an underground electric power system through port property, including construction of concrete transformer house, wires to carry 11,000 volts. Total estimated cost, $17,000.

Ore., Baker—The Oregon-Idaho Investment Co. has leased the claims adjoining the E. & E. mining plant and plans to install electric machinery, including hammer drills, etc. The company will also install a water power plant. Total estimated cost, $25,000. J. Arthur Baker, Mgr.

Ore., Portland—The Commission on Public Docks, foot of Stark St., plans to install one air compressor with a piston displacement of 44 cu. ft. per minute. C. B. Hegardt, Portland, Engr.

Ore., Portland—J. Jacobberger, Arch., Board of Trade Bldg., is receiving bids for the construction of a 4 story, 50 x 100 ft., club building on Park and Taylor Aves., for the Knights of Columbus. Separate bids for installation of plumbing and heating will be received. Total estimated cost, $100,000.

Ore., Portland—Multnomah County is having plans and estimates made by the Northwestern Electric Co. for the installation of new heating system in the court house here. Estimated cost, $25,000.

CONTRACTS AWARDED

N. H., Troy—The Troy Blanket Mills has awarded the contract for the construction of a 4 story, 68 x 289 ft. factory, 2 story, 64 x 224 ft. picker house and a small addition to boiler house, to E. D. Ward Co., 82 Foster St., Worcester, Mass. Total estimated cost, $350,000.

Mass., Boston—The Union Wool Co., 10 High St., has awarded the contract for the construction of a 7 story, 100 x 200 ft. storehouse on Summer St., to W. F. Kearns Co., Devonshire. A low pressure heating system will be installed in same.

Mass., Brookline—Daniel Fineberg, Scolloy Bldg., will build an 8 story, 75 x 116 ft. apartment house on Beacon St. A steam heating system will be installed in same. Total estimated cost, $225,000. Work will be done by day labor.

Mass., Fall River—The American Thread Co., foot of Kerr St., has awarded the contract for the construction of an addition to its boiler house, to the Aberthaw Construction Co., School St., Boston. Estimated cost, $40,000.

Mass., Fall River—The Baufora Spinning Co., 206 Globe Mills Ave., has awarded the contract for the construction of a 3 story, 120 x 350 ft. mill addition, to the New England Concrete & Construction Co., 201 Devonshire St. A steam heating system will be installed in same. Total estimated cost, $400,000.

Mass., Framingham—The Town School Commission has awarded the contract for the construction of a 2 story, 157 x 261 ft. school on Lincoln St., to C. S. Cunningham & Sons Co., 23 Central Ave., Lynn. A steam heating system will be installed in same. Total estimated cost, $160,000.

Mass., Springfield—The Cathedral St. Michael, Elliott St., has awarded the contract for the construction of a 2 story, 80 x 148 ft. high school, to Michael Maloney, 18 Bell Ave. A steam heating system will be installed in same. Total estimated cost, $175,000.

Mass., Worcester—St. Peter's Roman Catholic Church, 929 Main St., has awarded the contract for the construction of a 2½ story, 70 x 130 ft. school house on Main and Ripley Sts., to Michael Maloney, 8 Bell Ave., Springfield. A steam heating system will be installed in same. Total estimated cost, $125,000.

R. I., Pawtucket—The Collyer Insulated Wire Co., 249 North Main St., has awarded the contract for the construction of a 2 story factory on North Main St. to Fred T. Ley & Co., Inc., 499 Main St., Springfield, Mass. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. J., Bayonne—The Board of Education has awarded the contract for the installation of heating and ventilating systems in the proposed Public Schools No. 1 and No. 4, to Gillis & Geoghan, 537 West Broadway, New York City. Estimated cost, $31,439, for each school.

N. J., Elizabeth—The Wilys Corporation has awarded the contract for the construction of a 1, 2 and 4 story plant here, to Warren, Moore & Co., Colonial Bldg., Philadelphia. Estimated cost between $6,000,000 and $10,000,000. Contractors will sub-let power and heating systems.

N. J., Orange—The Orange Memorial Hospital has awarded the contract for the construction of a 4 story hospital addition to E. E. Paul Co., 101 Park Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $250,000.

N. J., Washington—The Globe Indemnity Co., 45 William St., New York City, will build a 6 story, 100 x 200 ft. office building on Washington St., here. A steam heating system will be installed in same. Total estimated cost, $400,000. Work will be done by day labor.

N. Y., New Rochelle—The Board of Education has awarded the contract for the construction of a 3 story grade school, to Emil Diebitsch, 383 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. Y., New York—J. J. Astor, London, England, has awarded the contract for the construction of a 31 story, 66x98 ft. office building at 8-12 Wall St., to R. H. McDonald, 29 West 34th St. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

N. Y., New York—The Banker's Trust Co., 16 Wall St., has awarded the contract for the construction of a 15 story office and bank building on 57th St., to R. H. McDonald, 29 West 34th St. A steam heating system will be installed in same. Total estimated cost, $400,000.

N. Y., New York—Louis Gold, 44 Court St., Brooklyn, will build a factory at 533 West 57th St. A steam heating system will be installed in same. Total estimated cost, $200,000. Work will be done by day labor.

N. Y., New York—The Montefeiro Home, 210th St. and Gun Hill Rd., has awarded the contract for the construction of a 5 story home, to Hegeman Harris, 33 West 42nd St. A steam heating system will be installed in same. Buchman & Kahn, 56 West 45th St., Arch. and Engr.

N. Y., Kings Park—The State Hospital Commission, Capitol, Albany, has awarded the contract for the installation of a steam heating system, in the proposed hospital for acute patients, at the Kings Park State Hospital here, to A. B. Barr & Co., 6 River St., Yonkers, $21,800. Noted Sept. 23.

N. Y., New York—The Board of Education, 500 Park Ave., has awarded the contract for the installation of a heating and ventilating system in Public School No. 147, to Hartel & Davis, 480 Clermont Ave., Brooklyn, $5437.

N. Y., New York—The United Odd Fellows Home, Havemeyer Ave., has awarded the contract for the construction of two 3 story, 50 x 75 ft. and 27 x 56 ft. dormitory buildings to J. A. Henderson, 30 East 42nd St. A steam heating system will be installed in same. Total estimated cost, $125,000.

N. Y., Portchester—The Mint Products Co., Inc., 299 Madison Ave., New York City, has awarded the contract for the construction of a factory to the Turner Construction Co., 244 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $400,000.

N. Y., Staten Island—Fraser, Brace & Clark Dry Dock Co., Inc., 47 West 34th St., New York City, has awarded the contract for the construction of a ship repair plant, to consist of eight 1 story, 50 x 100 ft. buildings, to the Fraser, Brace & Co., Inc., 47 West 34th St., New York City. Steam heating systems will be installed in same. Total estimated cost, $1,800,000.

N. Y., Syracuse—Stewart F. Hancock, O. C. C. S. Bldg., has awarded the contract for the installation of a plumbing and heating system in the proposed 3 story, 67 x 130½ ft. office and loft building, on South Salina St., to W. George & Co., 122 North Warren St. Estimated cost, between $10,000 and $12,000.

N. Y., Thiells—F. A. Vanderlip, Pres. of the Board of Managers of Letchworth Village, 7 Wall St., New York City, has awarded the contract for installing heating systems in the proposed eight new buildings, to John C. Williams, Inc., Woolworth Bldg., New York City, at $132,872; electric work to Wheeler-Green Electric Co., 29 St. Paul St., Rochester, at $7677. Noted Aug. 19.

Pa., Philadelphia—The Stanley Company of America, 1214 Market St., has awarded the contract for the construction of a 1 story, 143 x 176 ft. theater building at 19th and Market St. to the Keystone State Construction Co., Franklin Bank Bldg., Philadelphia. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

D. C., Washington—The Washington, Baltimore & Annapolis Electric Railroad Co. has awarded the contract for the construction of an 11 story, 200 x 200 ft. hotel and railroad terminal on 11th and 12th Sts. and New York Ave., to F. C. Lewin, 616 12th St., N. W., Washington, D. C. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

Ohio, Cleveland—The Euclid 71st St. Co. has awarded the contract for the construction of a 3 and 4 story, 195 x 283 ft. garage and service building on Euclid Ave. and East 71st St. to Craig Curtiss Co., Guardian Bldg. Two sectional tube boilers and a blower fan system will be installed in same. Total estimated cost, $500,000.

Ohio, Cleveland—The Cleveland Automobile Co., East 131st St. and St. Claire Ave., has awarded the contract for installing a steam power plant (high pressure piping) in the proposed 4 story, 80 x 200 ft. factory on Euclid Ave. and London Rd. to W. G. Cornell Co., Leader News Bldg. Total estimated cost, $350,000.

Ohio, Cleveland—The Euclid-Windsor Co. has awarded the contract for the construction of a 2 story, 90 x 194 ft. garage and an 8 story, 90 x 200 ft. office building at East 46th St. and Euclid Ave. to Sam W. Emerson Co., 1900 Euclid Bldg. Steam heating and power plants, transformers, switchboards and motor generator will be installed in same. Total estimated cost, $2,000,000.

Ohio, Cleveland—The J. Guide Motor Lamp Co. has awarded the contract for the construction of 1 story, 120 x 500 ft. factory, including a boiler house on West 110th St. to the Crowell-Little Co., 1957 East 57th St. Two water tube boilers, feed pump and engine will be installed in same. Total estimated cost, $200,000.

Ohio, Cleveland—The Euclid East 46th Street Market House Co. has awarded the contract for the construction of an 1t story, 115 x 250 ft. market house on East 46th St. and Euclid Ave., to the Kamp Building Co., East 46th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $200,000.

Ohio, Cleveland—The Marcus Loew Theatre Co., c/o Joseph Laronge, Mgr., 214 Williamson Bldg., has awarded the contract for the construction of a 4 story 125 x 175 ft. theatre on 17th St. and Euclid Ave., to the Fleischman Construction Co., 316 Permanent Bldg. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Cleveland—The Ohio Blower Co., c/o W. E. Clement, Secy., 9301 Detroit Ave., has awarded the contract for the construction of a 5 story, 65 x 300 ft. factory, to Sam W. Emerson Co., 1900 Euclid Bldg. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Dayton—The Maxwell Motor Co., Leo St., has awarded the contract for the construction of a 1 story, 45 x 60 ft. boiler house and a 100 x 120 ft. factory, to the Blanchard Building Co., Chapel Rd. Total estimated cost, $25,000.

Ill., Chicago—The Packard Motor Car Co., West Grand Blvd., Detroit, Mich., has awarded the contract for the construction of a 2 story, 298 x 304 ft. service and assembly station on West 37th St. and Princeton Ave., to Edward L. Scheidenheim, 111 West Monroe St., Chicago. Steam heating equipment, consisting of 2 boilers, air compressor and motor driven pump, will be installed in same.

Ill., Chicago—William Wrigley, Jr., 5 North Wabash Ave., has awarded the contract for the construction of a 16 story, 138 x 160 ft. office building at 400 North Michigan Ave., to the Languist & Illsley Co., 1100 North Clark St. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Ill., East St. Louis—Morris & Co., National Stockyards, will build a 2 story, 30 x 112 ft. power plant at the stockyards, here, and will be in the market for power equipment such as motors, generators, turbines, engines, etc. Total estimated cost, $75,000. Work will be done by day labor.

Ill., Urbana—The Wesley Foundation has awarded the contract for the construction of a 2 story, 150 x 170 ft. college, to English Brothers, Champaign. A steam heating system will be installed in same. Total estimated cost, $250,000.

Mich., Detroit—The Board of Education, 50 Broadway, has awarded the contract for installing heating, ventilating and plumbing systems in the proposed 2 story school, on Kenelworth Ave., to Irvine & Meier, 2289 Woodward Ave., $32,488.

Mich., Detroit—John Kalbfleisch, 293 Commonwealth Ave., has awarded the contract for the construction of a 2 story, 60 x 100 ft. laundry on McGraw Ave., to Harvey Zens, 471 Beddig St. A steam engine, boiler and generator will be installed in same. Total estimated cost, $45,000.

Mich., Grand Rapids—Berkey & Gay Co., Monroe Ave., have awarded the contract for the construction of a 5 story, 160 x 220 ft. factory and office building on Monroe Ave., to the Owen-Ames-Kimball Co., Michigan Trust Bldg., 42 Pearl St., Grand Rapids. Separate heating and power plant will be installed in same. Total estimated cost, $400,000.

Mich., Lansing—The Oldsmobile Division of the General Motors Corporation, Isaac St., has awarded the contract for the construction of a 4 story, 50 x 300 ft. administration building on Isaac and Logan Sts., to H. G. Christman Co., 302 Union Trade Bldg., South Bend, Ind. Steam heating equipment will be installed in same. Total estimated cost, $533,000.

Wis., Menomonee Falls—The Board of Education has awarded the contract for the installation of a steam heating system in proposed high and grade school, to W. M. Tuckwell, 86 Michigan St., Milwaukee.

Wis., St. Frances—The Nash Motors Co., Kenosha, has awarded the contract for the construction of a 1 story, 50 x 100 ft. power house, to the Northwestern Bridge & Iron Co., 32nd and Hopkins Sts., Milwaukee. Estimated cost, $75,000.

Ia., Winterset—The Board of Education has awarded the contract for installing plumbing and steam heating systems in the proposed 3 story, 82 x 140 ft. school, to Wallace & Linnane, 912 Walnut St., Des Moines. Estimated cost, $28,112.

Minn., Hibbing—The Oliver Mining Co., Wolvin Bldg., Duluth, has awarded the contract for the construction of a 4 story, 125 x 135 ft. hotel on Howard St., to C. F. Haglin Sons Co., Minneapolis. A steam heating system will be installed in same. Total estimated cost, $375,000.

Minn., Minneapolis—The Northern Bag Co., 101 3rd Ave., S., has awarded the contract for the construction of a 6 story, 150 x 300 ft. bag factory, on Washington Ave., N., to H. M. Leighton, 125 10th St., S. A steam heating system will be installed in same. Total estimated cost, $600,000.

Mo., St. Louis—The Board of Education, 9th and Locust Sts., has awarded the contract for the construction of a 3 story, 71 x 167 ft. school at 6017 Southwest St., to E. Gerhard, 615 Post Dispatch Bldg. A steam heating system will be installtd in same. Total estimated cost, $209,000.

Ore., Mt. Angel—St Mary's Parish, 345 4th St., Portland, has awarded the contract for the installation of a steam heating system in the proposed school building, to F. X. LeDoux, Henry Bldg., Portland. Total estimated cost, $100,000.

Ore., Salem—The state plans to install a circulating steam heating system in all the cells in the state penitentiary, here. Estimated cost, $2500. B. Olcott, Governor. Work will be done by convict labor.

Cal., Los Angeles—The Board of Public Service, 645 South Olive St., will build a 15 mile transmission line from here to San Pedro. A. C. Vroman, Secy. Work will be done by day labor.

Cal., Pasadena—The Board of Education has awarded the contract for installing a heating system in the proposed 2 story school building on the William McKinley School site, to Munger & Munger, 174 East Union St., $8127.

Ont., Hamilton—The Spectator Printing Co., James St., has awarded the contract for the construction of a 3 story, 60 x 100 ft. printing office and factory on James St., S., to Stewart & Sinclair, 17 Jackson St. A vacuum steam heating system will be installed in same. Total estimated cost, $100,000.

Ont., Walkerville—Hiram Walker & Sons have awarded the contract for the installation of one turbine driven unit with capacity of 5,000,000 imperial gallons per day, to the Turbine Equipment Co., 304 Excelsior Life Bldg., Toronto. Estimated cost, $26,000. Unit consists of two simple stage pumps, one connected to turbine by reducing gear, the other connected by magnetic clutch.

B. C., Port Coquittam—The Gregory Tire & Rubber Co., Standard Bank Bldg., Vancouver, will build a 3 story, 70 x 180 ft. factory and a 3 story, 60 x 80 ft. boiler house, here. Total estimated cost, $75,000. Work will be done by day labor.